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PLATE 1

Headquarters and Laboratory of Department of Terrestrial Magnetism, Washington, D. C.

RESEARCHES OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM

VOLUME II

LAND MAGNETIC OBSERVATIONS 1911-1913

AND

REPORTS ON SPECIAL RESEARCHES

BY

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AND

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LAND MAGNETIC OBSERVATIONS

1911-1913

By L. A. Bauer and J. A. Fleming

LAND MAGNETIC OBSERVATIONS, 1911-1913.

INTRODUCTION.

The present publication is the second of the series by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington bearing the general title "Researches of the Department of Terrestrial Magnetism." Under this head the results of the various operations and researches conducted by this Department are being published. While the subject treated at first is chiefly that of the Earth's magnetism, from time to time memoirs will appear on other more or less closely allied subjects. With the increased facilities for research, as related in another section of this volume, the various subjects can now be given increased attention, both in the field and in the laboratory.

Each volume has a subtitle setting forth briefly its special contents. Thus the first volume, designated in future as Volume I and entitled "Land Magnetic Observations, 1905–1910," contained the results of all magnetic observations made on land by the Department from the beginning of its observational work in February 1905 to the end of December 1910. The present volume, No. II, on "Land Magnetic Observations, 1911–1913," similarly contains the results of all magnetic observations made on land, this time those obtained during the three years, January 1, 1911, to December 31, 1913. There will also be found reports on certain special researches.

One of the special objects—the general magnetic survey of the globe—for which the Department of Terrestrial Magnetism was founded on April 1, 1904, is now rapidly nearing completion. According to present expectations, this general survey for the portion of the globe between about parallels 70° N. to 65° S. will be completed at the end of 1916. As stated in the Introduction to Volume I,

> The chief endeavor on our part is to secure magnetic results in the regions where most needed and where there are no organizations prepared to undertake the work. Where magnetic surveys are in progress under competent direction and where the prospects for early completion are favorable, the Department confines its work to the observations necessary for the proper correlation of results obtained with different instruments and by different methods and renders such assistance to organizations as may be required.

While the Department, as before, has extended special aid at times to certain organizations, for the effective and expeditious accomplishment of their objects, one of such cases being the Australasian Antarctic Expedition, 1911–1914, it is a pleasure to be able again to record and gratefully acknowledge here the cordial and valuable aid it has itself continued to receive from magnetic institutions in all parts of the world, as well as from the governmental and diplomatic representatives of the countries visited by the various observers.

It may be of interest to summarize briefly the operations of the nine years' work of the Department, on land and sea, from 1905 to 1913, inclusive:

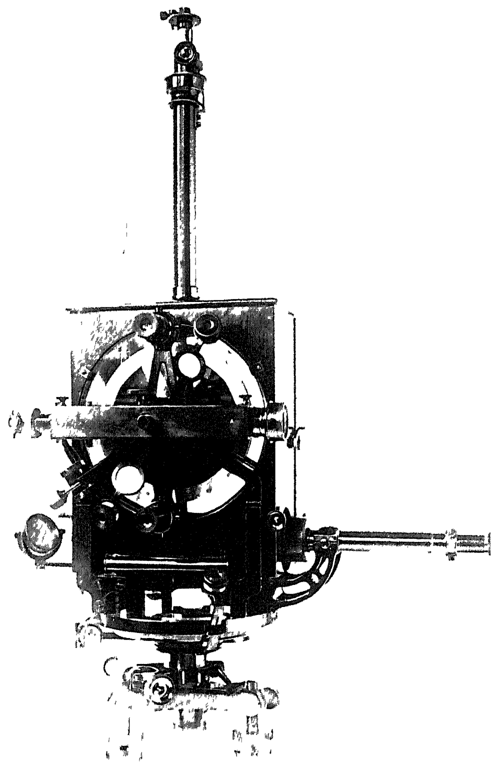
Mileage covered on the cruises of the *Galilee* (1905–08) and the *Carnegie* (1909–13), the magnetic elements having been determined completely, on an average, about every 175 miles.	160,600
Mileage covered by land expeditions in the establishment of about 2,500 stations in all parts of the Earth, at an average distance apart of 75 miles, roughly	800,000
Total mileage traveled by ocean and land expeditions, in round numbers, about forty times the circumference of the Earth	1,000,000
Number of land expeditions sent out	38
Number of Arctic expeditions cooperated with	4
Number of countries in which magnetic work was done:	
Africa	28
Asia	10
Australasia	7
Europe	8
North America	13
South America	13
Island groups, Atlantic Ocean	8
Island groups, Pacific Ocean	13
Island groups, Indian Ocean	3
Total	103

In connection with these operations, a non-magnetic vessel, the first of its kind, the *Carnegie*, was built in 1909; an office and laboratory building, containing 44 rooms, was erected in 1913 at Washington to provide the necessary facilities for the varied research work of the Department (Plate 1); 7 magnetic instruments, for special use on land and at sea, were devised and constructed in the workshop of the Department, and about 125 articles and publications on various phases of the work have appeared under the authorship of various members of the investigational staff.

Adding to the work of the Department that accomplished by other organizations, it may be said that on January 1, 1914, the general magnetic survey of the globe was fully two-thirds completed. It is gratifying to say that the surveys by other organizations are being conducted in cooperation with our design of a general magnetic survey of the globe. The magnetic standards used by the respective organizations are compared from time to time with our standards, thus making possible a strict correlation of all magnetic data obtained the world over. As an indication of the general interest evinced, the following resolution may be cited, which was passed at the St. Petersburg meeting of the International Association of Academies held in May 1913:

> The committee, in view of the work of making a magnetic survey of the globe, particularly on the oceans, undertaken by the Carnegie Institution of Washington, resolves that it is of the highest importance that similar work be completed as soon as possible, in those countries where no surveys exist or where they have been made at epochs relatively distant from those of the Carnegie Institution of Washington.

Great Britain has just undertaken a new magnetic survey of the British Isles as based on the fundamental Rücker and Thorpe survey, and various surveys have been recently either completed or initiated by European nations. In South America the Department may take advantage of the valuable work being conducted by Argentina and by Brazil, and in North America the magnetic researches of the United States Coast and Geodetic Survey and of the Canadian Government are at its service. In return, the Department furnishes its own acquired data freely whenever called upon.



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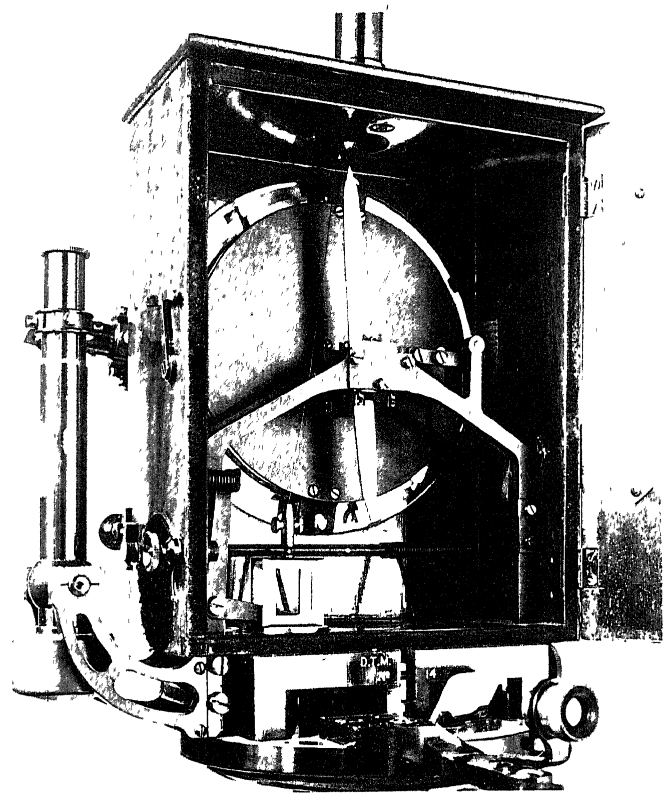

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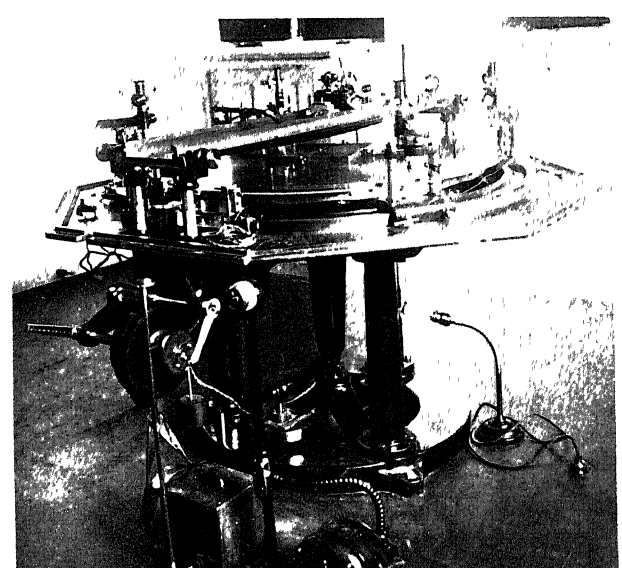

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1, 2, 3. Combined Magnetometer and Dip Circle.

[Universal magnetometer of type 4 (*b*).]

4. Dividing Engine for Graduation of Instrument Circles.

While the figures given in the above summary show that, thanks to the means provided by the Trustees of the Carnegie Institution of Washington, and the zeal of the observers, a large amount of work has been accomplished of interest not alone to the investigator of the Earth's magnetism but to the geographer and to the geologist as well, the record we may be proudest of is the fact that the entire work described was accomplished without loss of life. It is not possible to individualize here the remarkable work accomplished by the various observers. Suffice it to say that many of the expeditions, frequently embracing comparatively unexplored regions, have been attended with more or less danger, and have presented special difficulties which had to be surmounted. They represent geographic achievements as well as scientific work successfully accomplished under trying conditions. Thus, for example, in the present volume will be found the results obtained on such special expeditions as the difficult coastal trip in Western Africa, the crossing of the Sahara from Algiers to Timbuktu and thence to Lagos, Nigeria; the complete crossing of Australia from south to north, and of South America from east to west and north to south; extensive canoe expeditions in British North America to Hudson Bay, etc.

The general methods followed, both in the observational work and in the computational, as described in Volume I, have continued the same. The instrumental equipments have also been, in general, the same as before, with the exceptions which will be found noted in the proper place. Likewise the results have been tabulated in accordance with the decisions previously reached. The interested reader must be referred to Volume I for any desired information under these heads, as also for specimens of observations and of computations and descriptions of some of the instruments, with accompanying illustrations.

DESCRIPTIONS OF INSTRUMENTS.[1]

MAGNETOMETERS.

Since the publication of Volume I, the Department of Terrestrial Magnetism has designed and constructed two new styles of the universal type of magnetometer. The designations of these, as well as those described in the previous volume (pp. 2–11.) are as follows:

1. The so-called theodolite-magnetometer type in three designs, viz: (*a*) and (*b*) of the Department of Terrestrial Magnetism, similar, respectively, to magnetometers Nos. 3 and 13, and (*c*) of the United States Coast and Geodetic Survey, similar to No. 20.
2. The Kew type of magnetometer in two designs, with auxiliary theodolites for astronomical work, viz: (*a*) the regular design as constructed by Elliott Brothers, similar to No. 73, and (*b*) the Magnetic Survey of India design, similar to No. 36.
3. The light and portable type used in the Magnetic Survey of France, similar to No. 11.
4. The universal magnetometer type in three designs, viz: (*a*) the design of Eschenhagen and constructed with modifications by Tesdorpf, similar to No. 2025; (*b*) the design of the Department of Terrestrial Magnetism, similar to Nos. 14, 19, 20, 21, and 22; (*c*) the design of the same Department, similar to Nos. 23, 24, 25, 26, and 27.

[1]For Progress Report on "Improvement of Appliances for Measurement of the Earth's Magnetic Elements by Magnetic and Electric Methods," see L. A. Bauer's article in *Terr Mag.*, vol. 19, pp. 1–18.

The first three types, and design (*a*) of type 4, have been described and illustrated in detail on pages 2 to 7 of Volume I.

The magnet, stirrup, and suspension systems for all of the new instruments, listed above under type 4 and made by the Department of Terrestrial Magnetism, are similar in detail and dimensions to those for theodolite-magnetometers manufactured by the Department of Terrestrial Magnetism of the type 1(*b*). These will be found described in detail in the above reference to Volume I. Small differences, owing to slight mechanical alterations, are sufficiently indicated in Table 1, which gives the details and constants of the various magnetometers used in the present work.

The suspension fiber for the new instruments is a phosphor-bronze ribbon; for ordinary work in the field this ribbon is of section 0.010 by 0.127 mm. For inertia determinations a

TABLE 1.—*Details and Constants of Magnetometers Used, 1911-1913*

[Magnetometers Nos. 2 to 10 inclusive were manufactured by the Bausch and Lomb Optical Company of Rochester, New York, and are all, except for minor mechanical details, of the same type, namely, 1 (*a*), as described in Volume I; the magnets are hollow cylinders, the long magnets being 7.5 cm long, 0 75 cm inside diameter and 1 00 cm. outside diameter; the short magnets are 3.50 cm. long, 0 60 cm inside diameter and 0 82 cm. outside diameter. Magnetometers Nos. 12 to 25 were manufactured in the instrument shop of the Department of Terrestrial Magnetism. Nos. 12, 13, 15, 16, and 17 (No. 18 of the same type is not yet completed) are of the theodolite-magnetometer type 1 (*b*) as described in Volume I. Magnetometers 14, 19, 20, 21, and 22 are of the universal type, 4 (*b*), and are described on pages 7–9 of the present volume (see Pl. 2). Magnetometers Nos. 23 to 25 are of the combined magnetometer and earth-inductor type which is described on pages 9–12 (see Pl. 3). The magnets for Nos. 12 to 25 inclusive are all of the same type, being hollow cylinders made as nearly perfect as mechanically possible, the long magnets having the length 5 60 cm., inside diameter 0.60 cm., outside diameter 0 79 cm.; short magnets, length 2 60 cm., inside diameter 0 45 cm , outside diameter 0.65 cm. The suspension used for all the instruments referred to in the table is phosphor-bronze ribbon, this material replacing the use of silk entirely in the field work of the Department. The deflection distances used for magnetometers Nos. 2 to 10 inclusive are 25, 27 5, 30, 35, and 40 cm , and for magnetometers 12 to 25 inclusive, 20, 25, and 28 cm.]

[The C G S system of units is used throughout the table, the value of *q* is given for 1° C]

No.	Type	Diameter horizontal circle	Moments of long magnets at 20° C.		Distribution coefficients		Induction coefficient	Temperature coefficient	Scale value for declination	Remarks
			Inertia	Magnetic	*P*	*Q*	*h*	*q*		
		cm.							′	
2	1 (*a*)	12 5	162	612	+15 78	−1000	0.0116	0.00035	1 50	
3	1 (*a*)	12.5	166	624	+10 71	+1000	0.0088	0 00041	1 49	Department standard
4	1 (*a*)	12 5	156	625	+14 87	− 881	0.0116	0 00035	1 49	
6	1 (*a*)	12 5	243	560	+13 61	− 361	0 0078	0.00046	1 48	
7	1 (*a*)	12 5	239	580	+16 51	−1277	0.0063	0 00048	1.49	
8	1 (*a*)	12.5	237	485	+14.67	+ 24	0.0063	0.00037	1 48	
9	1 (*a*)	12 5	240	455	+15 01	− 468	0.0078	0.00044	1 48	
10	1 (*a*)	12 5	238	581	+13 25	+ 490	0.0063	0 00035	1 50	Before July 1912.
10[1]	1 (*a*)	12 5	238	581	+13 25	+ 490	0.0063	0 00035	1 52	After July 1912.
12	1 (*b*)	10 1	66	295	+ 7.67[2]	. ...	0.0094	0.00047	2 03	
13	1 (*b*)	10.1	66	280	+ 7.55[2]	. .	0 0101	0 00060	2 05	
14	4 (*b*)	10 1	66	280	+ 7 81[2]	.	0 0093	0 00060	1 95	
15[3]	1 (*b*)	10.1	66	285	+ 7.49[2]	.	0 0104	0 00045	2 00	
16	1 (*b*)	10.1	65	285	+ 7 36[2]	.	0 0087	0 00047	1 93	
16[4]	1 (*b*)	. .	64	.	+ 7 53[2]	.	0 0087	0 00047	1 93	After April 1913
17[5]	1 (*b*)	10 1	65	288	+ 7 55[2]	. .	0 0094	0 00049	1 96	
19[5]	4 (*b*)	12.0	65	285	+ 7 60[2]	.	0 0091	0 00048	2 15	
20[5]	4 (*b*)	12.0	65	283	+ 7 34[2]	. .	0 0096	0 00049	2 14	
21[5]	4 (*b*)	12.0	65	232	+ 7.61[2]	. .	0 0112	0 00052	2 15	
22[6]	4 (*b*)	12.0	65	266	+ 7 36[2]	.	0 0093	0 00047	2 15	
23[7]	4 (*c*)	10.2	65	311	+ 7 69[2]	. .	0 0107	0 00045	2 29	
24	4 (*c*)	10 2	65	307	+ 7 54[2]	..	0 0094	0 00051	1 97	
25	4 (*c*)	10 2	65	310	+ 7 54[2]		0 0095	0 00044	1 97	

[1]New scale added in July 1912.

[2]These values given for P are the values of P', assuming that $(1+P'r^{-2}) = (1+Pr^{-2}+Qr^{-4})$; this implies that the theoretical condition, $Q=0$, holds, since the dimensions of magnets were selected accordingly.

[3]Constructed for Meterological Service of Canada.

[4]After extensive alterations and readjustments had been made.

[5]The magnetometers here numbered 17, 19, 20, and 21 are not the same as those correspondingly numbered and illustrated in Volume I, which are the property of the United States Coast and Geodetic Survey.

[6]Constructed for the Magnetic Observatory of the Imperial University of Kazan, Russia.

[7]Constructed for the Physical Laboratory of the Technological Institute, Tomsk, Siberia, Russia.

somewhat heavier grade is used. At Washington, where the horizontal intensity is about 0.20 C.G.S., the torsion for the lighter ribbon, for the suspension-length used, amounts to about 5 minutes of arc for 90 degrees of twist. The total length of suspension, that is, the distance from the bottom of the ribbon clamp at the suspension head to the center of the magnet when in place, is from 326 to 375 mm. for magnetometers of type 4(*b*), and from 314 to 364 mm. for the combined magnetometer and earth-inductor type 4(*c*). Ordinarily the total length is about 340 mm. although in some cases longer, depending on the adjustment of the elevating screw of the upper suspension head when the magnet is in the center of the field of the magnetometer telescope.

The scale by means of which the position of the collimation line of the magnet is referred to the horizontal-circle setting consists, as in the previous instruments made by the Department, of sixty divisions engraved on the plano-parallel glass diaphragm of the magnetometer telescope. As before, particular attention has been paid to the engraving of these scales to insure accurate graduations and such suitable width of the engraved lines as to permit of sharp and definite readings and estimations. The deflection bar for each of the two new styles of instrument is of rectangular cross-section, 5 mm. thick and 15 mm. deep, mounted just below the magnet house, being centered and securely held in place by two slightly tapered pins, one at each side of the house in the case of type 4(*c*). In the universal magnetometers of type 4(*b*), because of the greater weight of the casting supporting the magnet house than is the case with the other instruments and the consequently much broader and better bearings, the bar is held in place by one tapered pin mounted in the center of the instrument and operated by a milled head. For centering and protecting the magnet against sudden changes of temperature during deflection observations, it is mounted in a specially constructed wooden box. The lower end of the magnet-centering pin of the deflection box is finished so as to fit snugly in rectangular grooves of the deflection bar at three distances, 20, 25, and 28 cm., thus insuring invariability of the deflection distance. For maintaining the vertical plane of the center, two broad arms extend down to the metal base of the box the full depth of the deflection bar, against which a heavy spring on the rear side presses them; a suitable counterweight is suspended on the opposite side of the deflection bar to maintain the level of instrument during deflections.

COMBINED MAGNETOMETER AND DIP CIRCLE.

This universal magnetometer, of type 4(*b*), is completely assembled in one unit, comprising astronomical telescope and magnetometer for the determination of magnetic declination and horizontal intensity, and dip circle for determination of inclination and total intensity; when mounted on its tripod, it is therefore always ready for immediate use. The advantage of being able to proceed with any one of the desired observations, without first assembling a number of parts, is evident and permits one to embrace every available opportunity for work.

The base, horizontal circle, and center are practically identical, as regards graduation and verniers, with those of the theodolite-magnetometer, except a heavy top-plate attached to the base to provide means for the securing of the heavier upper works of this intrument. The level attached to the base has a sensitiveness of 30 seconds of arc.

The astronomical telescope, of magnifying power 18, is mounted eccentrically, the distance between the center of the instrument and its vertical plane of collimation being 63 mm. for No. 14 and 82 mm. for the others of this type listed in Table 1. (See Plate 2, Fig. 1.) It is provided with a swiveled prismatic eye-piece and suitable shade-glasses for solar observations. The single, strong telescope-standard is securely mounted on the base casting supporting the magnet house; the bearing for the axis of the telescope is 18 mm. long for No. 14 and 37 mm. long for Nos. 19, 20, 21, and 22. This standard also carries the various

attachments for dip-circle microscopes, vertical circle, reading lenses, clamps, etc. The graduated vertical-circle and counterpoise plate are mounted in the magnet house at the end of the telescope bearing and behind a plano-parallel glass window, somewhat larger in diameter than the circle. The counterpoise proper, consisting of a cylindrical brass weight, is attached to an arm moving with the upper works which carry the magnet house and theodolite.

The vertical circle is 101 mm. in diameter and graduated at 30-minute intervals, the least count on the two verniers being one minute of arc, but estimations being easily and definitely made for one-half minute. It is fixed in position, the verniers moving with the telescope.

The magnet house is of well-seasoned mahogany, carefully finished, polished, and reinforced as necessary to prevent any warping. Plate 2, Fig. 2, shows the interior of the house when the instrument is used for dip observations.

The magnetometer telescope, of magnifying power 8, is supported in two wyes secured to the base in such a way that its line of sight is central. As will be seen in Fig. 2, Plate 2, the wyes are, for economy in packing-space, quite near the object end of the telescope, which is suitably counterweighted. (In the figure, the telescope is shown in a vertical position, as it is when not in use; when observing for declination, or when making the oscillation observations, the telescope is, of course, turned into a horizontal position.) The counterweight serves the additional purpose of making possible the elimination of the objectionable features of the hood arrangement in the theodolite-magnetometer. The end surface of the counterweight is part of a sphere of large radius; there is a spherical-surfaced depression of like size and radius in the outer face of the end of the house; the depression is lined with velvet and so made that when the telescope is horizontal, or nearly so, the two surfaces make a snug fit, thus preventing any currents of air entering the house. The window and illumination-device at the south end of the house are somewhat modified over those of the theodolite-magnetometer. The plano-parallel glass for keeping out currents of air, the iris diaphragm, and the mirror and reflector are assembled together, the whole being attached to the box and swinging on a hinge, so that when mark readings are desired the clamping pin may be removed and the system thrown over to prevent interference; when observations are being made it is of course put back into position and clamped. In order to have the center of the magnet house free for the dip work, the stirrup as shown in Fig. 2, Plate 2, is clamped in one corner of the house, and the suspension head is sufficiently elevated to make the bronze ribbon nearly taut, and so out of the way of the needle. The detail of the clamping arrangement by knee lever and spring, in the lower left-hand inside corner of the house, will be seen from the figure.

The supports for the agates of the dip circle, used for the needle bearings, are attached securely to the base independently of the house. They are made of shape similar to the telescope standard in order that there may be as little interference of parts as possible in sighting on the needle ends. The needle lifter is operated with the aid of an eccentric and lever, by a milled head on the south end of the house. The dip needles were made by Dover, and are of the usual land pattern, except as regards length, being somewhat longer in order that the ends may project beyond the vertical circle. The sighting microscopes are a little unusual in that the object lenses are mounted inside of the magnet house and fixed permanently to the counterpoise plate so as to move with the verniers, while the remainder of the optical arrangements are mounted outside; this arrangement has proved satisfactory. It should be noted that no matter what position the needle may take it is always possible to read the upper end; by observations made on either side, it is a comparatively easy matter to supply the data for the parts of the circle where the lower end is obscured by interference of the supports.

Attachments for total-intensity observations, according to Lloyd's statical method, were provided only in the case of universal magnetometer No. 14, the deflecting needle being

mounted on suitable supports attached to the telescope, which is at right angles to the line of sight of the microscopes. Magnetometers 19, 20, 21, and 22 of this type were not thus provided. For, as the result of field experience with No. 14, the thickness of the web of the standard supports was increased in these instruments; this made the distance available for the use of the total-intensity method too great for the dip needles of the size that could be used. Magnetometer 14 is supplied with two pairs of dip needles and two pairs of intensity needles. Nos. 19, 20, 21, and 22 have each two pairs of dip needles.

Plate 2, Fig. 3, shows the instrument mounted on the tripod, and with the deflection bar inserted for deflection observations.

Magnetometer 14 is equipped with a tripod having legs of the telescoping pattern; this style of tripod, unless carried in the hand, is not entirely suitable for packing, as the numerous screws and nuts are quite likely to be bent during transportation. Magnetometers 19, 20, 21, and 22 accordingly have been equipped with tripods somewhat similar in pattern to that usually supplied with dip circles manufactured by Dover. This type is not much heavier than the telescoping pattern and, because of its simpler construction, is a superior tripod for general transportation.

The inside dimensions of the instrument cases for magnetometers of the type 4(*b*), except for slight variations with individual instruments, are about as follows: length 48 cm., width 25 cm., depth 21 cm.; the outside dimensions are about 2 cm. more each way. The weight of the instrument with all appurtenances, but exclusive of the case, is about 7 kilograms; the case weighs about 6 kilograms, so that the total weight of instrument and case is about 13 kilograms. The weight of the tripod and deflection bar is about 4 kilograms.

COMBINED MAGNETOMETER AND EARTH INDUCTOR.

Owing to the difficulties generally experienced in the satisfactory determination of the corrections of dip needles on adopted standard and the possible changes in these corrections with geographical variation in magnetic intensity and inclination and with wear of pivots of the needle, it was found desirable to improve further the universal magnetometer of the Department of Terrestrial Magnetism by substituting for the dip circle an earth inductor. The comparisons made with earth inductors by the observers of the Department in various regions of the globe have been far more satisfactory than the dip-circle comparisons. Accordingly an instrument combining the earth inductor with the magnetometer was designed and constructed in the shop of the Department. The instrument consists essentially of four parts: (*a*) the base, (*b*) the magnetometer attachment, (*c*) the earth-inductor and theodolite attachment, and (*d*) the galvanometer. The effort has been to secure a compact, portable instrument, with a minimum number of loose accessories, for rapid field work of high precision.

The base (see Plate 3, Fig. 1) is of the usual double-center type. The horizontal circle is 102 mm. in diameter, with graduations at 30-minute intervals and with two verniers, the least count of each vernier being one minute of arc; the graduation is such, however, that estimations to one-quarter minute of arc can readily and definitely be made. The base is supported by three foot-screws.

The magnetometer attachment (see Plate 3, Fig. 1), including magnet system and suspension, is similar to that of the theodolite-magnetometer of type 1(*b*) described in Volume I. A small improvement over the type there described has been made by the elimination of the hood connection between the magnetometer telescope and the magnet house. The hood has been replaced by an attachment with concave, plush-lined spherical surface attached to the magnet house, and against which an adjustable cap with corresponding convex spherical surface mounted at the object end of the magnetometer telescope is in contact when the telescope is horizontal. This permits free vertical motion of the telescope when making sightings on marks slightly elevated or depressed and, at the

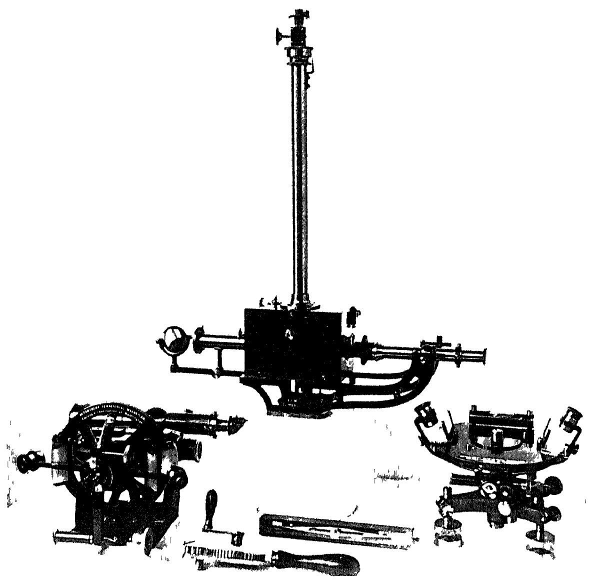
same time, serves effectually to keep any currents of air out of the magnet house. The magnetometer attachment, including its telescope and suspension, is packed assembled and may be mounted on the base in one operation by a device similar to that described for the theodolite-magnetometer.

The inductor and theodolite attachment (see Plate 3, Fig. 1, and Plate 4, Fig. 1) consists of a U-shaped standard frame supporting an inner ring in which are provided agate bearings to carry the inductor coil; the telescope and vertical circle are mounted on the axle ends of this ring outside of the standards. The center of the telescope is 78 mm. from the center of the instrument. The telescope has a magnifying power of about 17. Suitable shade glass and a prismatic eyepiece are provided for astronomical observations. The reticle is a small cross of two fine fibers at right angles. The vertical circle is 102 mm. in diameter and has the same style of graduation as the horizontal circle, being read directly to one minute of arc by two verniers and by estimation to one-quarter minute. The circle is attached to the axle of the bearing ring in such a way that the relation of the line of sight of the telescope to the zero graduation of the vertical circle is constant, and the vertical circle rotates with the telescope. The two verniers are fixed in position by suitable framework attached to the standards of the instrument. The graduated circle is protected by a sheath of brass with uncovered openings at the verniers. To protect the circle and verniers against tarnishing, they are coated with lacquer.

The ring carrying the bearings for the coil is oval-shaped, the inner smaller diameter being 80 mm. and the inner greater diameter about 103 mm. The section of this ring is about 8 mm. by 10 mm., with suitable lugs cast on at the points where the axle supports and coil bearings are placed. The bearings for the rotation axis of the coil are of agate, the bearing surfaces being cone-shaped. The bearing at the commutator end is the smaller; the one at the opposite side is larger, to permit the drilling along the center axis of a hole of sufficient diameter (4 mm.) to permit of making attachments for the pin connection for the flexible shaft used for rotating the coil. The cap carrying the agate bearing at the commutator end is provided with adjustments for careful centering, while that carrying the opposite bearing has a longitudinal adjustment along the axis to permit the taking up of any slight wear or lost motion in the bearings.

The coil is mounted on a hard-rubber spool 24 mm. thick; the inner diameter of the spool is 26 mm. and the outer 74 mm. The winding consists of 0.23 kilogram of double-wound silk magnet wire, Brown and Sharpe gage No. 28, in 49 layers and 2,062 turns; at every third layer of wire there is a double layer of paper; the width of the winding is 18 mm. and the outer diameter 71 mm.; the resistance of the coil is 68 ohms. The coil is covered with a heavy coating of paraffin to protect it against possible abrasion and short-circuiting of the turns and against moisture. The ends of the phosphor-bronze rotation axis for the coil spool are attached to the hard rubber by means of two U-shaped brass straps. The commutator is mounted on a core of fiber. The brushes are of hard copper attached to the brass supporting-ring by screws and insulated from it by hard-rubber sleeves and washers, and connected to insulated wires running in grooves in the ring and terminating at the binding posts (Plate 4, Fig. 1) at the extremity of the axle on the side of the vertical circle of the instrument. Suitable means for clamping the vertical circle and for slow motion are provided. For the purpose of facilitating more rapid approximations, a micrometer head is attached to the slow-motion screw and a suitable index provided; motion through three divisions on this head corresponds approximately to one minute of arc on the vertical circle.

The magnetic meridian may be determined by direct and reverse sightings with the telescope on a mark of known magnetic azimuth. As this method, however, is not always feasible, a compass (see Plate 4, Fig. 1) is added for determining the magnetic meridian. Mounting for the compass is provided on the ring supporting the inductor coil, the ring



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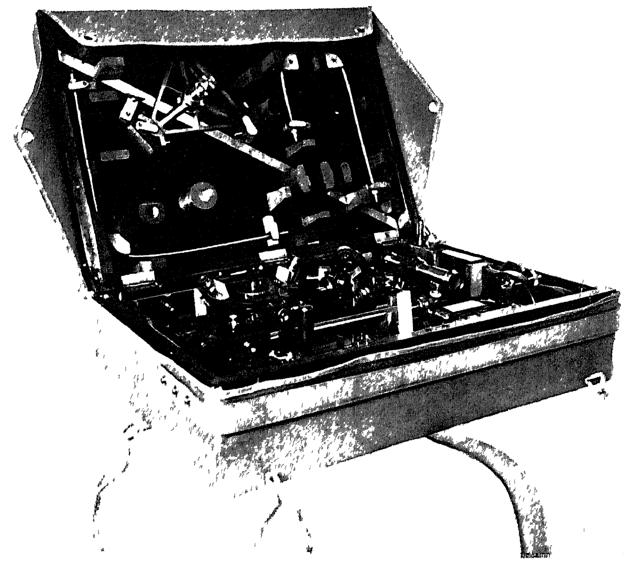

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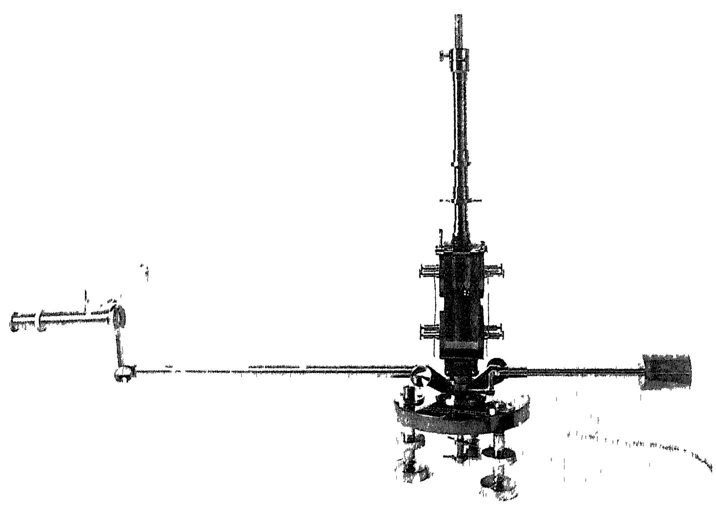

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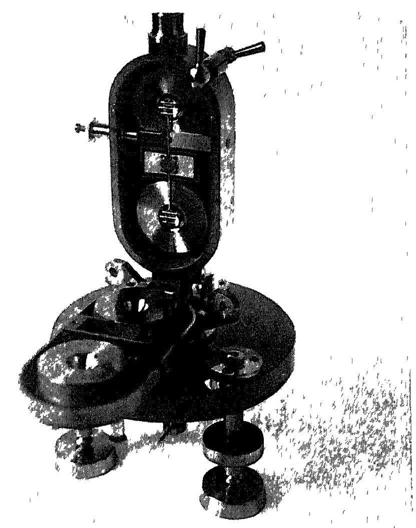


4

Combined Magnetometer and Earth Inductor.
[Universal magnetometer of type 4 (c)]

1. Attachments and appurtenances
2. Instrument packed in its case
3. General view of galvanometer
4 Interior view of galvanometer

being placed in a horizontal position by setting the vernier zeros of the vertical circle at 0° and 180°. The needle, 120 mm. long, is mounted in a brass case with index mirrors at the north and south ends, and readings are effected by shifting the instrument until the needle point and its reflection in the mirror are in the same vertical plane with the index line on the mirror surface. A balancing weight for the needle is mounted on a long screw. The needle may be balanced by removing the end cap provided with a brass knob after removal of the three screws holding the cap in place; the glass cover-plate is then drawn out, the needle taken from the tube, and the balance weight screwed in or out, as may be necessary. In replacing the needle, it is first replaced on the pivot, and the cover glass and cap are then mounted.

The coil is rotated by means of a flexible shaft consisting of two closely wound spirals of phosphor-bronze wire operated by two gears attached to a crank handle.

The *galvanometer* (Plate 3, Figs. 3 and 4) is of the Kelvin type. The spindle center for this instrument is mounted in a hard-rubber base 100 mm. in diameter and 12 mm. thick, which in turn is supported by three leveling foot-screws insulated from the center by the rubber base. The four coils are each wound with 80 grams of double-wound silk magnet wire, Brown and Sharpe gage No. 34; there are 1,880 turns in each coil. The outside diameter of the winding of each coil is about 30 mm., the inside 4 mm., and the thickness about 9 mm. The resistance of each coil is 86 ohms. They are so arranged that they may be easily connected either in series or multiple. The terminals are each lettered, and the coils are in series when the connections are made in the order of the alphabet, namely, *A*, *B*, *C*, *D*, *E*, *F*, *G*, and *H*. The connections from the earth inductor are made at *A* and *H*. Each pair of coils is mounted on a hinged frame, so that the galvanometer house may be easily opened and new suspension inserted or other repairs made, as may be necessary. The spools of the coils are carefully insulated from the brass parts of the instrument by the use of hard rubber.

The magnet system, consisting of six magnets, is mounted in two groups of three by means of sealing wax in two light brass frames supported by a phosphor-bronze wire. In order that the system be astatic as closely as possible, the magnets are very carefully made and magnetized in accordance with the methods followed in the manufacture of magnetometer magnets. The six magnets used for the galvanometer system consist of two 8 mm. long and 0.8 mm. in diameter, and four 6.4 mm. long and 0.8 mm. in diameter. The sheet-brass pieces which carry the magnets are 0.15 mm. thick, and each stamped with grooves to support the magnets. The phosphor-bronze wire supporting the damping vane, mirror, and magnet system is 0.6 mm. in diameter. The air-damping vane of sheet brass is 0.05 mm. thick, 8 mm. wide, and 20 mm. long, and mounted at center of system. The mirror is attached directly to the light brass damping vane by tongues stamped from the vane itself. The air damping is effected by means of the brass vane and a rectangular box provided between the coils; in the half of this box mounted on one coil frame there has been mounted at the center a V-shaped piece to increase the efficiency of the air damping. Attachments for control magnets are provided on the suspension tube and on a support mounted below the hard-rubber bearing-plate. These arrangements are friction-tight, so that the control magnets may be adjusted as desired either vertically or in azimuth. The control magnets are made very small, and it has been found that in case all are used no effect is produced on the inclination when the galvanometer is mounted at a distance of one meter from the inductor. At Washington, D. C., it has not been found necessary to make use of the control magnets when the coils are connected in series. The suspension is of very fine cocoon fiber, about 0.006 mm. diameter. The fiber is attached to a rod mounted in a ring, in which it may be clamped by means of a set-screw, and the height so adjusted. This ring in turn rests upon a second ring permanently attached to the suspension tube, on which there is a second clamping-screw, which serves to permit turning

the suspension and removing torsion of the fiber. The entire length of the suspension from the point of attachment to the magnet system is about 120 mm. A special clamp has been provided for clamping the magnet system in place when the instrument is being transported or when not in use. This is shown in Plate 3, Fig. 4; it consists of one fixed arm with a V-cut surface to receive the brass wire of the suspension, and a second movable arm with corresponding V-surface at its end, held in place by a spring operated through a milled nut on the outside of the instrument. When this nut is loosened the spring forces the movable arm against the fixed arm, clamping the suspension. The clamping surfaces in contact are sufficiently long to insure no deformation of the suspension system.

A plano-parallel glass window has been provided in the damping-box on one side of the instrument, so that readings may be made by means of a telescope and scale. The telescope and scale, with counterweight and arms carrying the same, are mounted on a ring outside the spindle bearing of the instrument, and may be placed in any azimuth independent of the position of the house of the galvanometer; a suitable lever-clamp is provided, so that the arms may be clamped in any position. The arms carrying the counterweight and telescope and scale are so arranged that they may be folded against the instrument for transportation; the reading telescope, however, must be unscrewed from its mounting when packing the instrument in its case. The telescope is supplied with a simple reticle of two fibers at right angles. The distance between the object lens of the telescope and mirror is about 25 cm. The scale is on white xylonite, and is 10 cm. long, with graduations at every millimeter; it is mounted somewhat above the horizontal line through the center of the mirror, while the telescope is mounted a corresponding distance below this line. The relations of the scale, telescope, and mirror always being fixed, it is not difficult to find the reflection of the scale, so that the instrument may be quickly set up and adjusted for field use.

The galvanometer is supplied with an independent tripod, and is clamped in place on this tripod by means of a slip-plate with notches fitting into corresponding grooves in the three foot-screws.

The instrument case for the entire instrument is made of mahogany, the inside dimensions being 36 cm. wide by 51 cm. long by 14 cm. deep, the material being 1.6 cm. thick. All parts of the instrument, including accessories, the two tripod heads, and the deflection bar are packed in this instrument case, the total weight of which, with the instrument and its accessories, is 15.3 kilograms (see Plate 3, Fig. 2). The net weight of the instrument, with its appurtenances, but not including the two tripod heads, is 7.2 kilograms; the two tripod heads weigh 1.1 kilograms, and the instrument box 7 kilograms. The tripod legs for the two tripods are carried separately in a canvas carrying case, the total weight of the tripod legs and case being 6.8 kilograms.

DIP INSTRUMENTS.

The dip circles used in obtaining the data given in the present volume were of the following patterns, of which the first two are fully described and illustrated in Volume I, pages 7 to 10: (*a*) the regular Kew land-pattern as made with slight variations by Dover and by Casella; (*b*) the Lloyd-Creak ship-pattern as originally designed by Captain Ettrick W. Creak and made by Dover with some modifications introduced by the United States Coast and Geodetic Survey and by the Department of Terrestrial Magnetism, according to L. A. Bauer's specifications; dip-circle attachment of universal magnetometer of type 4(*b*); earth-inductor attachment of universal magnetometer type 4(*c*). Types 4(*b*) and 4(*c*) have already been described in the preceding pages of this volume.

EARTH INDUCTORS.

The types of earth inductor used were: (*a*) the design originated by Wild[1] and as modified by Eschenhagen, described and illustrated in Volume I and represented in the Department's equipment by No. 48 constructed by Schulze, and No. 2 constructed by Toepfer & Sohn; (*b*) earth inductor of the type made by the Department of Terrestrial Magnetism for the determination of dip at sea and as represented by earth inductors Nos. 3 and 4; earth-inductor attachment of universal magnetometer of type 4(*c*), described and illustrated in this volume.[2]

Type (*b*) is the style of instrument originally made by the Department of Terrestrial Magnetism for observations at sea. The elements of the apparatus as used at sea are essentially: (1) an improved form of gimbal stand that will maintain an average mean position of equilibrium but which permits complete reversal of the gimbal rings and bearings in order to eliminate errors of level (the description of this gimbal stand will be given in a later volume containing the detailed results of the observations at sea; in the meanwhile the interested reader may be referred to the journal *Terrestrial Magnetism*, vol. 18, pages 40 and 41); (2) a portable form of earth inductor with such means for rotating the coil as will not in any way when in use disturb the gimbal rings; and (3) a galvanometer of sufficient sensibility suitable for use at sea.

The *earth inductor* constructed for this apparatus is shown in Plate 4, Fig. 2. The double-center base is of the usual pattern used for theodolites, with three leveling foot-screws and slow tangent-motions for each center. The graduated horizontal circle is 120 mm. in diameter, the least graduation being 30 minutes of arc; it may be read, by means of two verniers, directly to one minute of arc, the very sharp, clean graduations permitting estimations to one-quarter of a minute. The lower center of the base is not necessary, but for this inductor the double-center base was used simply because it was in stock, and thus made possible the early completion of the instrument. The standard carrying the ring in which the coil is mounted and on which the rotating gear and the vertical-circle verniers are also mounted, is attached permanently to the base. The ring carrying the bearings for the rotation axis of the coil is 78 mm. inside diameter; in it, at right angles to the axle supports in the standards, are provided centering and bearing agates, and to it are attached the vertical circle and the commutator brushes with suitable wire connections to two binding posts through the horizontal axle on the vertical-circle side of the instrument. To make possible the more accurate adjustment of the brushes, it was originally contemplated to make them adjustable around the axis of the commutator, but this was not done because of the mechanical complications that would have been introduced. Care was used, however, to set the brushes very closely to eliminate the necessity, for practical purposes, of this adjustment. The vertical circle is 102 mm. in diameter, with a least graduation of 30 minutes of arc; it may be read directly, by two fixed verniers, to one minute and, by estimation, to one-quarter of a minute. Suitable means for clamping vertical circle and for slow motion are provided.

The bearings of the rotation axis of the coil are of brass, being V-shaped in longitudinal section and running in agate cups burnished in the brass centering supports in the supporting ring. The coil is held in place by two U-shaped pieces of brass which carry the bearing ends of the rotation axis. At one end of the rotation axis is mounted the commutator and, at the other end, a miter gear for use in the rotation of the coil. The spool of the coil is made of hard rubber[3] of 24 mm. outside thickness and of 74 mm. outside diameter.

[1]Wild, H. Inductions-Inclinatorium neuer Construction und Bestimmung der Absoluten Inclination mit demselben in Pawlowsk. St. Petersburg, *Mem. Ac. Sc*, Ser 7, v 38, No 3, 1891.

[2]For a special study on "The Theory of the Earth Inductor as an Inclinometer," made by Dr. N E Dorsey in 1912, see his article in *Terr. Mag*, vol. 18, pp. 1–38.

[3]This material was used instead of brass because of the greater mechanical ease of maintaining insulation and eliminating induction effects.

The inside diameter of the winding of the coil is 26 mm., the outside diameter, 73 mm., and the width of winding, 17.5 mm. There are 65 layers (3,162 turns) of double-wound silk magnet wire, No. 30 Brown and Sharpe gage, with a double thickness of paper at every fifth layer. For protection against moisture conditions encountered on board ship and against possible abrasion and short-circuiting of the turns, the outer surface of the coil and its connections are heavily coated with paraffin. The resistance of the coil is about 175 ohms.

For the purpose of determining the magnetic meridian, a sighting telescope and a compass are provided, suitable mounting wyes being placed so that the line of sight or the magnetic axis of the needle will be in the vertical plane through the rotation axis of the coil. The magnetic meridian may thus be determined by sighting upon marks of known magnetic bearing or by actual observation of the compass. Parallax in the compass readings is avoided with the aid of mirrors mounted immediately below the ends of the needle.

The gearing for rotating the coil of the earth inductor is self-contained. A hole has been drilled through the center of the spindle and a shaft mounted in it with a miter gear at the upper end in suitable bearing; this engages a second miter gear mounted on a shaft set at about 45° from the vertical in fixed bearings on the standard frame. A third gear at the upper end of the inclined shaft engages a similar miter gear attached to an axle rotating in the center of the horizontal bearing-end of the supporting ring. Inside of the supporting ring there is attached to this axle a gear of 102 teeth mounted in a hollow spherical frame which permits the coil to turn freely inside it, and engages a gear of 25 teeth attached to the rotation axis of the coil.

For the purpose of rotating the coil at land stations, a special tripod clamp has been provided with a bearing for turning the crank which is connected with the center shaft in the spindle bearing by means of brass shafts and two universal joints. The weight of the present earth inductor is about 5 kilograms, while that of the Wild-Eschenhagen pattern is about two and a half times as much. The comparisons of it with the standard earth inductor of the latter pattern have been extremely satisfactory, the resulting difference being on the order of about 0.1 minute.

The *galvanometer* used is of the moving-coil type, manufactured by the Leeds & Northrup Company, of Philadelphia, with some slight modifications specified by the Department of Terrestrial Magnetism. The moving coil is suspended between straight upper and lower suspensions of 0.002-inch phosphor-bronze ribbon. These suspensions have proved to be amply strong for carrying the instrument about and for the more or less rough motions encountered during heavy seas on board ship. The coil may be clamped in position when not in use by means of a sliding clamp at the back of the tube and the tension of the suspension fibers adjusted by a sliding rod and set-screw at the lower end of the tube. The tube containing the coil and suspensions may be quickly removed by loosening two clamping nuts and readily replaced by a reserve tube, if necessary. A glass window allows easy inspection of the system. The reflecting mirror has a plane surface. The galvanometer resistance is 317 ohms and the critical damping resistance about 125 ohms. The deflections are as nearly as possible proportional to current and the sensibility practically the same for negative deflections as for positive ones. The sensibility specified was 1 mm. at scale distance 1 meter $=10^{-8}$ ampere. The period is about 2.4 seconds. To prevent corrosion and warping, owing to the hygrometric conditions at sea, the magnet and core are protected by paint and the base is made of hard rubber. The stray magnetic field was specified to be as small as possible. This galvanometer has been used for the land determinations by the observing staff of the *Carnegie*, care being taken always to see that it is sufficiently removed from the observing station to occasion no distortion of the Earth's magnetic field.

Inductor No. 4, made in the shop of the Department of Terrestrial Magnetism, and illustrated in Plate 4, Fig. 3, is in general detail entirely similar to the marine type just

described. As this instrument is intended entirely for land use the mechanism for the rotation of the coil was modified in such a way that the cup-shaped gear is rotated directly by a crank in the axle of the ring carrying the inductor coil. The galvanometer used with this instrument is of the Kelvin type as manufactured by the Leeds & Northrup Company, Philadelphia, Pa. (see Plate 4, Fig. 4). The coil-frame supports are mounted above the base by corrugated rubber pillars; brass tubes telescope over these pillars to protect them from dust when not in use. The four coils are each of about 31 ohms resistance and so arranged that they may easily be connected in series or multiple. The control magnets originally supplied by the manufacturer were discarded because they were of such size as to affect the results obtained for inclination when the galvanometer was mounted close enough to the instrument to permit one observer both to rotate the earth-inductor coil and to read the galvanometer; accordingly control magnets of smaller size were substituted. The galvanometer may thus be mounted within 3 feet of the earth inductor. This apparatus has been loaned to the Royal Alfred Observatory at Mauritius.

In using the earth-inductor attachment of the universal magnetometer it is essential that the tripods be mounted on pegs driven well into the ground. The screw adjustment of the commutator of the inductor should be such as to give a light, firm contact without too much friction, and the commutator should be kept well lubricated. The commutator end of the coil is always to be down, as otherwise the attachment for rotating the coil would interfere at times with the base of the instrument. In using the flexible shaft the coil is brought up gradually to full speed and stopped gradually (by careful handling the flexible shaft can be kept in good condition and any tendency towards kinking avoided). Particular care must be used to see that there are no loose connections either at the galvanometer or at the inductor, as these sometimes cause trouble. The inductor coil must always be carefully examined before making connections to make sure that there is no looseness in its bearings; any looseness is taken up by means of the milled nuts at the end of the bearing where the flexible shaft is attached, care being taken, however, to see that the bearings are not too tight, and particularly to see that they are clean and free from grit, dust, or sand. With these instruments it is particularly necessary that great care be given the level adjustment.

A list of the various circles and earth inductors used, together with the needles and their designations, will be found in Table 3, "Dip Corrections on Adopted C. I. W. Standard for the Period 1911–1913," pp. 17-20.

REDUCTIONS TO STANDARD INSTRUMENTS.

The world-wide operations of the Department of Terrestrial Magnetism have necessitated extensive intercomparisons of magnetic instruments at Washington as well as in the field and at magnetic observatories in the regions covered; the results of these intercomparisons to 1914 will be found on pages 211 *et seq.* With the data thus obtained it has been possible to refer the magnetic elements for the entire region embraced in Volume I and in this publication to magnetic standards within an error, in general, on the order of the error of observation. While the adopted standards are provisional, the numerous comparisons with magnetic observatory standards show that they approach so close to international ones that the corrections adopted may be considered as fulfilling all practical requirements of a general magnetic survey of the Earth.

MAGNETIC STANDARDS ADOPTED.

The *standards adopted* for reduction to a common basis of the results contained in this volume are the same as those of Volume I, viz: In declination, C. I. W. magnetometer No. 3 without correction; in horizontal intensity, C. I. W. magnetometer No. 3 with a correction of $+0.00015H$ applied to observed values of H, the horizontal intensity; in inclination, earth inductor No. 48, made by Schulze, with a correction of $-0'.5$ applied to observed values of inclination, this correction being based upon direct comparisons with the standard earth inductors at the Potsdam and the Cheltenham magnetic observatories, 1907–1908.

MAGNETOMETER CORRECTIONS.

The corrections of each magnetometer on the adopted standard were determined at Washington, before and after use of the instrument in the field, and also, whenever possible, in the field by means of intercomparisons with other outfits. The accuracy of the mean correction is usually within about $0'.2$ in declination and about $0.0001H$ in horizontal intensity. The tabulated corrections are to be applied algebraically, east declination being reckoned as positive and west declination as negative; horizontal intensity is always taken as positive.

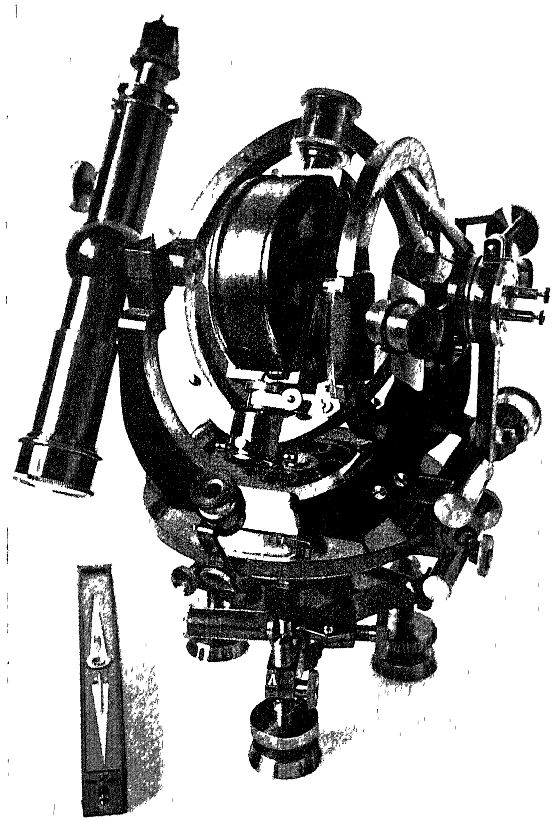
The tabulated H-corrections are those actually applied in the final reductions of the observations, except for magnetometers Nos. 12–23, for which the values as given in Table 2 are the equivalent corrections on the basis of P' (see Table 1) instead of P and Q originally used.

TABLE 2.—*Magnetometer Corrections on Adopted C. I. W. Standard for the Period 1911–1913.*

No. of magnetometer	Correction to observed: Declination	Correction to observed: Horizontal intensity	Remarks	No. of magnetometer	Correction to observed: Declination	Correction to observed: Horizontal intensity	Remarks
	′				′		
2	+0.1	−0.00010H		14	−0.7	+0.00028H	
3	0.0	+0.00015H	Standard instrument.	16	−0.1	+0.00015H	Prior to Apr. 13, 1913.
4[1]	+0.4	+0.00024H		16	+0.3	−0.00016H	Subsequent to Apr. 13, 1913, after extensive alterations and readjustments.
6	+0.2	+0.00075H		17[2]	+0.2	+0.00078H	
7	0.0	−0.00098H		19[2]	−0.2	+0.00039H	
8	+0.1	−0.00017H		20[2]	+0.4	+0.00072H	
9	+0.7	−0.00018H		21[2]	−0.1	+0.00070H	
10	−0.1	+0.00051H	New scale added July 31, 1912	22	+0.1	+0.00078H	
				23	+0.1	+0.00072H	
12	−0.2	−0.00013H					
13	−0.1	+0.00052H	Through Oct. 1911				
13	−0.1	−0.00006H	Subsequent to overhauling and readjustment of Nov. 1911.				

[1]The values given in Volume I applying subsequent to alterations and repairs of March 1910 are erroneous and should be amended according to the values here given.

[2]Nos. 17, 19, 20, and 21 are magnetometers manufactured by the Department of Terrestrial Magnetism and are not the same as the correspondingly numbered ones in Volume I, which are the property of the United States Coast and Geodetic Survey.



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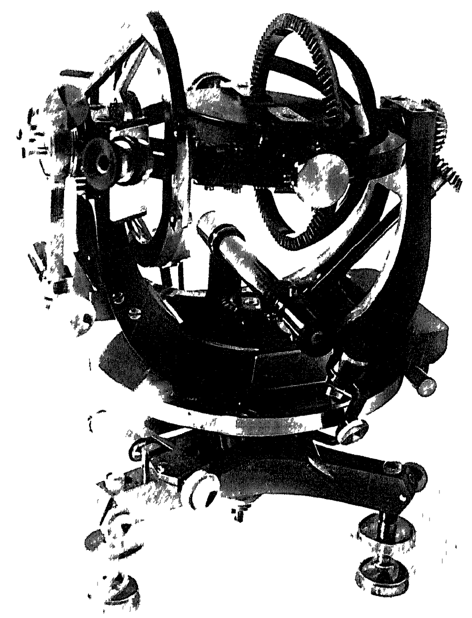

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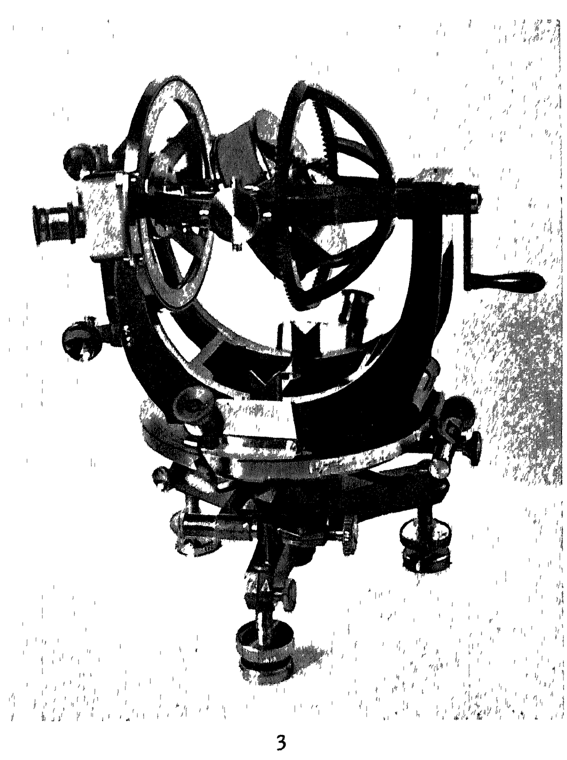

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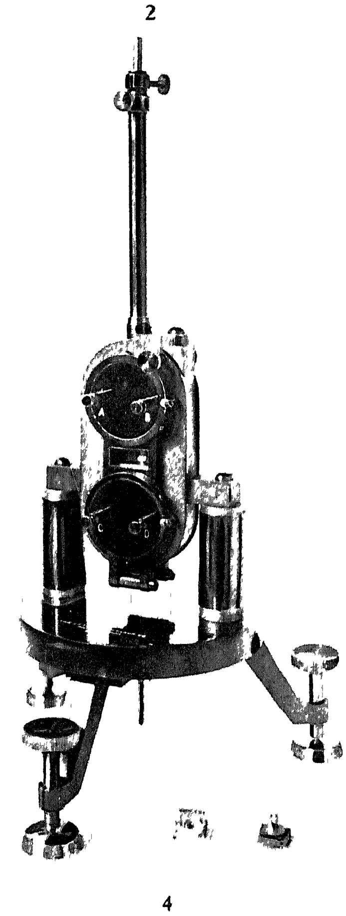

4

Earth Inductors and Galvanometer.

1 Type 4 (*c*) for use on land.

2. Type (*b*) for use on land and sea

3. Type (*b*) for use on land

4 Galvanometer used with type (*b*) for land work.

DIP CORRECTIONS.

In the regular dip, or inclination, observations, the polarity of needles is invariably reversed and hence the so-called balance error due to eccentric position of center of gravity of the needle is eliminated. There remains, however, the error due to irregularity of figure of pivot, and this will vary, in general, with the magnetic field. Hence the determinations of needle-corrections at a base-station, however carefully executed, may not necessarily apply to a region far remote, where the dip and intensity are considerably different. In determining the corrections, use has been made not only of the comparisons at Washington, but also of all available comparisons obtained in the field and at observatories. Where the reliable comparisons have been sufficiently numerous, a tentative relation of the following form has been established, F being the total intensity, I the inclination, and x, y, z, 3 coefficients to be determined:

$$F\Delta I = x + z \cos I + y \sin I$$

In the cases, however, where only a few reliable comparisons are available, and particularly in the tropics, where, because of the development of rust, a rapid deterioration of the dip needles is encountered, it has been necessary to depend for the corrections on a critical study of the differences exhibited by the needles among themselves, and then working back from these differences to the base-station corrections.

The dip corrections adopted for the various instruments used in the observations contained in this volume are given in Table 3; these corrections are to be applied algebraically, regarding dip, north end down, as positive, and south end of needle down, as negative.

Table 3 also gives the corrections for the compass attachments of the dip circles; these corrections are to be applied algebraically to observed results, regarding east declination as positive and west declination as negative.

TABLE 3.—*Dip Corrections on Adopted C. I. W. Standard for the Period 1911–1913.*

Instrument	Type[1]	Dip	Corrections for dip needle				Tabular designation	Correction for compass	Remarks
Barrow circle....	(a)	−86° to −89°	No. 1 0′.0	No. 2 0′.0	....	.....	B. 12	. . . .	Property of Christchurch Magnetic Observatory; loaned Australasian Antarctic Expedition.
			No. 1	No. 2	No. 5	No. 6			
		+70°	+0′.3	+1′.6	+0′.9	+0′.5			
		+60	+0.1	+1.2	+0.8	+0 3			
		+50	−0.2	+0.5	+0 5	−0.1			
		+40	−0.5	−0.1	+0 1	−0.4			
		+30	−0.8	−0.8	−0.2	−0.7			
		+20	−0.9	−1.4	−0.4	−1.0			
		+10	−0.8	−1.9	−0.6	−1.2			
Universal magnetometer 14.....	4(b)	0	−0.3	−2.3	−0.8	−1.4	14.1256	....	
		−10	+0.3	−2 6	−1.1	−1.5			
		−20	+0.8	−2.7	−1.4	−1.7			
		−30	+1.2	−2.6	−1.8	−1.7			
		−40	+1.0	−2.4	−1.9	−1.6			
		−50	+0.2	−2.1	−1.8	−1.4			
		−60	−0.9	−1.7	−1.5	−1.0			
		−70	−1.1	−1.1	−1.1	−0.6			

[1]For explanation of types, see p. 12.

TABLE 3.—*Dip Corrections on Adopted C. I. W. Standard for the Period 1911–1913*—Continued.

Instrument	Type[1]	Dip	Corrections for dip needle				Tabular designation	Correction for compass	Remarks
			No. 1	No. 2	No. 5	No. 6			
Universal magnetometer 19	4(*b*)	+70°	−0′.4	+0′.9	−0′.2	−1′.3	19 1256	....	Needles 1 and 5 are somewhat erratic in behavior and frequently results with them have had to be rejected on this account; this has been particularly the case for dips from −14° to −20°.
		0	−0.1	+0.6	−1.0	−1.0			
		−4	+3.0	−0.2	−0.5	−0.6			
		−8	+5.9	−1.0	−0.2	−0.3			
		−12	+8.1	−1.2	0.0	−0.1			
		−16	+8.7	−1.1	−0.1	−0.1			
		−20	+6.1	−0.6	−0.9	+0.2			
		−24	+3.0	+0.2	−2.5	+0.8			
		−28	+2.7	−1.2	−2.9	+1.0			
		−32	+3.6	−2.4	−2.5	+0.8			
		−36	+4.1	−1.8	−2.3	−0.1			
			No. 1	No. 2	No. 6				
Universal magnetometer 20	4(*b*)	+70°	−0′.5	−1′.0	−1′.2	.....	20 1256 or 20 126 (See remarks)	....	Needle 5 has been rejected for work subsequent to October 15, 1912, because of the development of large and variable polarity-difference, the correction for this needle for the work accepted was +0′.4. Some irregularities were indicated for needles 1 and 2 in the region of dips from +18° to +20°.
		+60	+0.8	−1.2	−1.0	.....			
		+50	+1.4	−1.4	−0.9	...			
		+40	+0.6	−1.5	−0.7	.....			
		+30	−1.6	−1.7	−0.7	.....			
		+20	−3.1	−2.0	−0.2	..			
		+15	−3.8	−2.4	+0.2	...			
			No. 3 of 19	No. 4 of 19	No. 3 of 20	No. 4 of 20			
Universal magnetometer 21	4(*b*)	+45°	−0′.2	+2′.8	−2′.3	+1′.3	21 (343)4)	..	Needles 3 and 4 of magnetometer 19 and needles 3 and 4 of magnetometer 20 used because the needles of No. 21 had not been completed when this instrument was assigned for field use.
		+40	+0.2	+1.9	−1.2	+0.6			
		+35	+0.8	+1.6	−0.4	−0.5			
		+30	+1.0	+1.2	−0.2	−0.6			
		+25	+0.5	+1.1	−0.6	+0.1			
		+20	−1.0	+1.5	+0.1	+1.1			
			No. 5	No. 6	No. 7 of 178	No. 8 of 178			
Barrow circle 41	(*a*)	−58° to −68°	−0′.3	−1′.7[2]	..	.....	41.56	....	Property of the Melbourne Observatory.
		−58 to −68	−0.3	+1.9[3]	....	.....			
		−45 to −55	....	...	−2′.5	−0′.2	41.(78)	....	
		−45 to −55	....	....	−2.5	−0.8[4]			
			No. 3	No. 4	No. 7	No. 8			
Dover circle 71[5]	(*a*)	+22° to +32°	−0′.6	+0′.9	−0′.8	−0′.7	71 3478	....	Property of the Hongkong Observatory.
			No. 5	No. 6					
Lloyd-Creak circle 169.[6]	(*b*)	−68° to −78°	+0′.2	+0′.6	.....	...	169.56	−3′.8(*a*) −2.2(*b*)	(*a*) When mark read by telescope; (*b*) When mark read by peep sights. 169 was extensively overhauled, repaired, and readjusted in February 1910.
			No. 1	No. 2	No. 7 of 177	No. 8 of 177			
Dover circle 171	(*a*)	+5° to −2°	−2′.1	−1′.7	−2′.8	−2′.6	171.12(78)	+0′.4	New pivots supplied for needles 1, 2, and 8 (of 177) and instrument extensively repaired and readjusted, October 1910.

[1]For explanation of types, see p. 12.
[2]For period July 31 to August 16, 1911.
[3]For period August 17 to December 1911; change pronounced but cause unknown.
[4]Subsequent to November 10, 1913, change due to sudden change in polarity-difference.
[5]The final compilation of corrections for circle 206, used in standardizing 71, showed that the provisional corrections adopted for 206 in Volume I for dip +31° are too great negative, so that the final corrections for 71 should be as given above and the dip values published in Volume I should be corrected, accordingly, by applying +0′.9.
[6]This instrument, used by the Australasian Antarctic Expedition during 1911 to 1913, was found generally an unsatisfactory type for polar work, owing to formation of frost in the jewel-bearings; for this reason it was also necessary to reject the observations for total intensity made with this instrument.

TABLE 3.—*Dip Corrections on Adopted C. I. W. Standard for the Period 1911–1913*—Continued

Instrument	Type[1]	Dip	Corrections for dip needle				Tabular designation	Correction for compass	Remarks
Dover circle 172	(*a*)		No. 1	No. 2	No 5	No. 6	172 1256	+0′.1	Because of very erratic behavior of needle 6, dips from −30° to −44° and from −55° to −56° were rejected, for dips between −60° and −67° a further correction of +4′ 5 to the tabulated value was clearly indicated. During 1913 needle 2 for dips from −65° to −67°.7 required a further correction of +3′.0.
		+47°	−1′.5	−1′.1	−1′ 8	−1′.8			
		+10	−2 .0	−1 .2	−1 4	−1 3			
		−32	−2 0	−1 .5	−1 .0	. . .			
		−36	−2 .0	−1 .6	−0 9	.			
		−40	−2 1	−1 .6	−0 8	.			
		−44	−2 3	−1 .6	−0 7	. .			
		−48	−2 5	−1 .5	−0 .6	−1 .4			
		−52	−2 .7	−1 .3	−0 .8	−1 .8			
		−56	−2 9	−1 .0	−1 .1	−2 .3			
		−60	−3 .2	−0 .7	−1 3	−2 8			
		−64	−3 .5	−0 .4	−1 .6	−3 .3			
		−68	−3 8	0 .0	−1 .8	−3 .9			
		−72	−4 .2	+0 .4	−2 .0	−4 .4			
Dover circle 177..	(*a*)		No. 1	No. 2	No. 5	No. 6	177 1256	+0′ 6[2] −1 .2[3]	Instrument cleaned and slightly overhauled in October 1911. The analysis of earth-inductor comparisons and field data, available for the period 1911 to 1913, indicated with slight modifications for dips below +20°, corrections substantially the same as for 1905 to 1910 work, reported on in Volume I.
		+70°	−1′.2	−0′.1	−0′.7	−0′ 6			
		+60	−1 .3	−0 .2	−0 2	+0 .2			
		+50	−1 .1	−0 .4	−0 2	−0 .1			
		+40	−0 9	−0 .4	−0 .5	−0 1			
		+30	−0 7	−0 .4	−0 8	+0 2			
		+20	−0 6	−0 .5	−0 8	+0 4			
		+10	−0 7	−0 .6	−0 8	+0 6			
		0	−0 9	−0 .4	−0 .8	−0 .4			
		−10	−1 2	−0 4	−0 .7	−4 .4			
		−20	−1 .4	−0 .4	−0 .7	−8 .7			
Dover circle 178 .	(*a*)		No 1	No 2	No 7	No 8	178 12378 (See remarks)	−2′ 5	Needles supplied with new pivots during latter part of 1910 and instrument generally overhauled. During use by Australasian Antarctic Expedition, correction for needle 3 deflected by 4 in total intensity work for dips −62° to −90° was +2′ 0, the logarithm of total-intensity constant for needle-pair 3 and 4 was 9.55301.
		−62°	−3′.0	−3′.8	−3′.6	−4′.4			
		−65	−3 7	−3 .1	−3 6	−3 .3			
		−70	−3 8	−1 .7	−2 .6	−2 .7			
		−75	−2 5	−0 7	−1 .5	−3 .5			
		−80	−1 0	−0 2	−1 2	−2 9			
		−85	+0 .9	−0 .3	−1 .1	−2 .5			
		−90	−0 .3	0 .0	+0 .1	+0 2			
Dover circle 201[4]	(*a*)		No 1	No 2	No. 5	No 6	201.1256	−4′.6	$F\Delta I = -0'.3 + 0'.8 \cos I - 0'.4 \sin I$ for needle 1. $F\Delta I = -1'.6 + 1'.9 \cos I + 0'.2 \sin I$ for needle 2.
		−5°	Formula	Formula	−1′.3	+2′.3			
		−30° to −45°	Formula	Formula	+2 .0				
Dover circle 202 .	(*a*)		No 1	No. 2	No. 5	No. 6	202.1256 or 202 1257 (See remarks)	−7′.5	These values apply during 1911 and 1912. The pivot of needle 6 was broken on May 22, 1911. Needle 7 was used subsequently in place of 6 but was found rather unsatisfactory, results by it for values of dip +23° to +36° were rejected, as its behavior in this region of dip was very erratic. The corrections adopted for needle 7 for period 1911 and 1912 were: +35°, −1′ 8; +40°, −1′.8; +45°, −2′.0; +50°, −0′.7; +55°, +1′.7
		+55°	+0′ 5	0′ 0	+0′.8	.			
		+50	+0 .5	0 .0	+0 .5	−1′ 0			
		+45	+0 .5	−0 .1	+0 .5	−1 .0			
		+40	+0 .6	−0 .6	+0 6	−0 9			
		+35	+1 .8	−1 2	+0 .7	−0 .7			
		+30	+1 .2	−1 6	+0 3	−0 .6			
		+25	−2 2	+1 9	−1 3	−0 4			
		+20	+0 .7	+1 .7	−1 .7	−0 3			
		+15	+2 .5	+0 .1	−0 .3	−0 .6			
		+10	+0 .8	−0 .9	+1 .5	0 .0			

[1]For explanation of types, see p. 12.
[2]Through September 2, 1911.
[3]After September 2, 1911; subsequent to repolishing of pivot and needle blade, and remagnetization of needle, in October 1911.
[4]Circle 201 has continued to be very satisfactory. It was possible, with the frequent comparisons for different values of the dip with a standardized earth-inductor at the *Carnegie* land stations, to improve the correction-formulæ for needles 1 and 2, these are, however, practically the same as found for 1905–1910 work. Needles 5 and 6 were used only at 2 stations.

TABLE 3.—*Dip Corrections on Adopted C. I. W. Standard for the Period 1911–1913*—Concluded.

Instrument	Type[1]	Dip	Corrections for dip needle				Tabular designation	Correction for compass	Remarks
			No. 1	No. 2	No. 5	No. 7			
Dover circle 202—Continued.	(*a*)	+60°	−0′.9	−0′.9	−0′.1	−1′.0	202 1257	−13′.7	During latter part of 1913. Subsequent to extensive overhauling, repairing, and readjusting in October 1913.
		+55	−0.6	−1.2	−0.1	−1.6			
		+50	−0.7	−1.3	0.0	−2.1			
		+45	−1.0	−1.3	+0.4	−1.9			
			No. 1	No. 2	No. 5 of 178	No 6 of 178			
Dover circle 206[2].	(*a*)	+70°	−0′.6	−0′.8	−1′.9	−2′.5	206 12(56)	+0′ 4	For needle 5, because of indication of pivot irregularities, the dips from +28° to +30° and from +32° to +34°, were rejected.
		+60	−0.8	−0.5	−1.6	−3.3			
		+50	−0.9	−0.4	−1.4	−4.1			
		+40	−1.1	−0.1	−1.1	−4.0			
		+35	−1.3	−0.2	−0.5	−3.6			
		+30	−1.3	−0.4	+0.7	−3.2			
		+25	−0.9	−0.6	+1.6	−2.6			
		+20	−0.8	−0.6	+1.3	−2.1			
		+15	−1.1	−0.5	+0.8	−1.5			
		+10	−0.5	−0.5	+0.1	−0.8			
		+ 5	−0.9	−0.9	−0.4	−0.1			
			No. 1	No. 2	No. 5	No. 6			
Dover circle 222 .	(*a*)	+84°	−0′.1	−0′.5	+0′.3	0′.0	222 12356 (See remarks)	+2′ 9	Corrections for needle 2 apply only for polarity *A;* the dips for polarity *B*, owing to the irregularities found, had to be rejected. Logarithm of total-intensity constant for needle-pair 3 and 4 is 9.55974. The corrections for needle 3 deflected are: *Dip. Correction. Dip. Correction.* +84° −0′.7 +76° +1′.2 +82 −0.4 +74 +1.2 +80 −0.2 +72 +0.4 +78 +0.4 +70 −0.3
		+82	−0.4	−0.8	+0.1	+0.3			
		+80	−0.2	−2.6	+0.9	+0.4			
		+78	−0.1	−1.9	0.0	−0.1			
		+76	−0.1	−2.2	−0.9	+0.3			
		+74	−0.2	−2.6	−0.9	+0.5			
		+72	−0.1	−2.7	−0.3	+0.5			
		+70	+0.1	−2.7	+0.4	+0.6			
			No. 1	No. 3	No. 5	No. 6			
Dover circle 223. . .	(*a*)	+70°	−1′.0	0′.0	−0′.4	−0′.6	223.1356	+4′.4	Needle 2 could not be used because the pivot was found to be defective.
		+60	−1.0	+0.1	−0.7	−0.5			
		+50	−0.8	0.0	−0.9	−0.3			
		+40	−0.6	−0.5	−0.9	−0.1			
		+30	−0.6	−0.9	−0.7	+0.1			
		+20	−1.0	−0.8	−0.4	+0.4			
		+10	−1.3	−0.3	−0.8	+0.1			
		0	−0.5	+0.4	−1.3	−0.7			
		− 5	+0.1	+0.7	−1.6	−1.3			
Earth inductor 2. .	.	All values	−0′.7	. . . . .	. . . .	. . . .	EI2	. . . .	Wild-Eschenhagen type, as made by Messrs. Toepfer & Son, with Department modifications.
Earth inductor 3	. . . . . .	All values	−1′.0	. . . . .	. . . .	. . . .	EI3	.	Marine type, made by Department of Terrestrial Magnetism.
Earth inductor 4	. . . . .	All values	−0′.2	. . . . .	. . . .	. . . . .	EI4	. . .	Land type, made by Department of Terrestrial Magnetism.
Earth inductor 48.	. . . . .	All values	−0′.5	. . . . .	. . . . .	. . . .	EI48	. . . .	Wild-Eschenhagen type, as made by Schulze.

[1]For explanation of types, see p. 12.
[2]The particulars regarding this instrument given in Volume I should be modified by the statement that needles 5 and 6 there referred to are of circle 178.

LAND MAGNETIC OBSERVATIONS, 1911-1913.

EXPLANATORY REMARKS.

Precisely the same conventions have been followed in the presentation of the field results obtained during the three years 1911 to 1913 as adopted in Volume I. These conventions, briefly recapitulated, are as given in the following paragraphs.

It has not been deemed advisable to attempt at present to apply corrections to the observed results on account of the numerous variations of the Earth's magnetism, *e. g.*, diurnal variation, secular variation, magnetic perturbations, etc. Instead, it is believed to be better to publish the observed results as obtained with no corrections applied except the reductions to the magnetic standards of the Department as fully explained in the section on this subject; thus undue delay is avoided in the promulgation of the results. The reduction to a common epoch can be undertaken more advantageously later, probably after 1914, when additional data have been secured. The reader will notice, however, that opposite the magnetic elements as tabulated in the Table of Results the precise date and local mean time of each observation are given; he is thus supplied with the required information in case, for some purpose of his own, it is necessary to reduce the observed values to some mean time.

The following main geographic divisions have been adopted: Africa, Asia, Australasia, Europe, North America, South America, Islands Atlantic Ocean, Islands Indian Ocean, Islands Pacific Ocean, and Antarctic Regions. Under each main division there are broad subdivisions (see Africa, for example.) The tabular entries under these subdivisions are in the order of decreasing north or increasing south latitude; that is to say, in the order of increasing co-latitude counting from the North Pole to the South. When there are stations of the same latitude, their order is according to increasing east longitude, counting continuously from the standard meridian of Greenwich or zero to 360 degrees.

The question whether to give values of the horizontal intensity exclusively, or values of total intensity, was decided, for practical reasons, in favor of the former. In the vast majority of cases, the horizontal intensity rather than the total is observed, and most likely will continue to be for some years at least. Only in high magnetic latitudes, where the horizontal intensity is small and hence its observation more or less difficult, are total intensities generally obtained. Rather than give total intensities, as derived by computation with the aid of the observed horizontal intensity and inclination, it was thought a better procedure to compute, in the considerably smaller number of cases, the horizontal intensity from the observed total intensity and inclination, the so-obtained values being italicized in order to reveal their derivation.

It was also decided to publish the intensities in C. G. S. units, one C. G. S. unit being designated by capital gamma, Γ. In magnetic-survey work on land the fourth decimal is often uncertain by one or more units and in ocean work the error may be five or more units in this decimal place. For these reasons it appears inadvisable for field results to adopt so small a unit as a small gamma, $\gamma = 10^{-5}$

C. G. S. unit = $10^{-5}\,\Gamma$; it would be necessary otherwise at times to round out the observed value by one or more zeros. This is avoided by the use of the larger unit; if the conditions under which an intensity result was obtained were such as not to warrant publishing the fourth or fifth decimal, this is shown by stopping with the decimal deemed certain. In general, however, as will be seen, the value to the fifth decimal is given, but it should be understood that no claim is made for the correctness in all cases of the last figure; it has been retained here primarily in order that when all reductions to common epoch have been applied on account of the magnetic variations, an error of a unit in the fourth decimal, due purely to computation, will not enter.

The first column in the table is headed "Station;" this gives the name of place at which the magnetic elements were observed, the spelling adopted being in accordance with the most reliable information at hand and conforming as far as possible to local usage. The next column gives the geographical position, latitudes and longitudes, as derived in most cases from the observers' local astronomical observations following the methods already described. When the latitudes are the results of fairly complete circummeridian observations of the Sun, or the means of several reoccupations of the same station, or are derived from reliable large-scale maps, then they are given to the nearest $0'.1$, though it should be distinctly understood that this accuracy is not guaranteed, as even for these cases the error may be as much as $0'.5$ and even in some instances a whole minute of arc. When the latitudes are given only to the nearest minute, there were either no astronomical determinations or they may have been incomplete or defective; these values are usually taken from standard atlases and for some regions may be in error by several minutes. Owing to the numerous sources of error of a longitude determination, and especially because of the uncertainty in more or less unexplored countries of the adopted chronometer-correction on standard time, the longitude in no instance is tabulated closer than to the nearest minute of arc. Usually it is derived from the observers' astronomical observations. Considerable use was also made of reliable large-scale maps, whenever available, and of standard atlases; the values in regions but slightly surveyed may be out sometimes by several minutes.

The date on which the magnetic observations were made will be found in the fourth column. The following abbreviations have been adopted for the months of the year: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. The values of the magnetic elements will be found in the next columns as observed at the local mean time, expressed to nearest 0.1 of an hour, opposite each value. In cases where the observations which make up the mean value are numerous and scattered over the various parts of the day, so that the mean may be practically taken as the mean of day, the local mean times are replaced by the word "various." Occasionally it has appeared desirable, where diurnal variation in declination was observed or where numerous observations were made during a limited interval, to give the local mean times of the beginning and of the end of the series and to indicate the number of determinations from which the mean value is derived by a number inclosed in parentheses: thus $9^h.1$ to $11^h.3(7)$ is to be read "the mean

is the result of seven determinations made during the interval $9^h.1$ to $11^h.3$, local mean time, inclusive;" $6^h.1$ to $20^h.3$ (dv) is to be read "eye readings of the suspended magnet were made regularly at short intervals from $6^h.1$ to $20^h.3$, local mean time." The local mean times are given according to civil reckoning and are counted from midnight as zero hour continuously through 24 hours; 16^h, for example, means 4 o'clock p. m.

The declination values, as also of inclination, are in general given in degrees, minutes, and tenths of minute of arc. For instruments which are not regarded as capable of yielding great accuracy only the nearest minute is given. The tabulation of values of the horizontal intensity has already been explained above.

The instruments used are shown in the columns Mag'r (magnetometer) and Dip Circle. When the number of an instrument in magnetometer column is italicized, it means that a dip circle has been used in getting the declination by means of the compass attachment and that total instead of horizontal intensity was observed. A designation in the column Dip Circle, *e. g.*, 206.12, stands for "Dip circle No. 206, needles Nos. 1 and 2;" 222.1256, for "Dip circle No. 222, needles Nos. 1, 2, 5, 6;" 171.12(78) for "Dip circle No. 171, needles Nos. 1 and 2 of No. 171 and 7 and 8 of another circle," as explained in Table 3, giving "Dip Corrections."

OBSERVERS.

In the last column of the Table of Results, the observer responsible for the observations is shown by his initials. Those engaged from time to time in the execution of the present work were as given in Table 4.

When observations were made jointly by two observers, this fact is shown by the combination of their last initials, as indicated in the latter part of Table 4.

For the land observations secured by members of the ocean party the abbreviation C II has been used for the second cruise of the *Carnegie*. Observers for the part of the second cruise for which this volume contains results were as follows: W. J. Peters, chief observer and commander; with Observers H. M. W. Edmonds

TABLE 4.—*Land Magnetic Observers, 1911–1913*

Observer	Designation	Observer	Designation	Observer	Designation
J. P. Ault	JPA	C. W Hewlett	CWH	E. N. Webb[3]	ENW
R. Bage[1]	RB	J F. Hurley[1]	JFH	D. M. Wise	DMW
J. M. Baldwin[2]	JMB	H F Johnston	HFJ	Ault and MacKenzie	A&M
L. A. Bauer	LAB	E. Kidson	EK	Ault and Power	A&P
D. W. Berky	DWB	A. L. Kennedy[3]	ALK	Ault and Schmitt	A&S
F. Brown	FB	C. T Madigan[1]	CTM	Bauer and Edmonds	B&E
C. R Carroll	CRC	D MacKenzie	DM	Brown and Kennedy	B&K
F. W. Cox	FWC	N. Meisenhelter	NM	Edmonds and Wise	E&W
C. C. Craft	CCC	Ngan Y. K[4]	NYK	Fleming and Galt	F&G
H M. W. Edmonds	HME	W. J. Peters	WJP	Kidson and Cox	K&C
C. K Edmunds	CKE	A. D Power	ADP	Kidson and Webb	K&W
H. W Fisk	HWF	H. E Sawyer	HES	Webb and Bage[1]	W&B
J. A Fleming	JAF	H R Schmitt	HRS	Webb, Bage, and Hurley[1]	W, B, H
H D. Frary	HDF	W H. Sligh	WHS	Webb and Kennedy	W&K
R H. Galt	RHG	C. C Stewart	CCS		
W. H Hannam[1]	WHH	W. F Wallis	WFW		

[1]Observers of the Australasian Antarctic Expedition. [2]Of the Melbourne Observatory.
[3]Originally with the Department of Terrestrial Magnetism, subsequently with the Australasian Antartic Expedition. [4]Chinese assistant observer

from March 1911 to February 1913, C. C. Craft to April 1911 and from February 1913, H. F. Johnston from March 1911 to April 1913, C. W. Hewlett from June 1912, H. D. Frary to June 1912, C. R. Carroll to February 1912, and N. Meisenhelter from March 1912.

While too much credit can not be given the observers for their portion of the work, those who have taken part at the office in the reduction and in the preparation of the results for publication should not be overlooked. Although the observers themselves when returning from the field have frequently taken their turn in making the final office-computations of one another's observations, the chief burden has been borne by Messrs. J. A. Fleming, H. W. Fisk, J. P. Ault, C. R. Duvall, J. H. Millsaps, H. D. Harradon, R. R. Mills, and J. J. Carey, all of the office personnel. Mention should also be made of the efficient services rendered by the chief mechanician, J. A. Widmer, and his assistants, in the construction and repair of instruments.

DISTRIBUTION OF STATIONS.

Some idea of the extent of the land work represented in the Table of Results may be obtained from the synopsis given in Table 5, showing the geographical distribution of the stations occupied during the three years, 1911-1913. Data have been secured in every continent, as also on numerous islands in the Atlantic, Indian, and Pacific Oceans, and, in cooperation with the Australasian Antarctic Expedition, in the Victoria Quadrant of the Antarctic Regions. The work has been chiefly in Australasia, South America, and Africa. The stations occupied during the three years' work embraced in the present publication, and as shown by the table total 983 (904 primary and 79 secondary), an average of about 325 per year. Of the primary stations, there are about 30 at which the full program, for some reason, could not be carried out, the data for one element being in consequence lacking. For the majority of these, however, magnetic results at secondary stations were secured. Practically all of the secondary stations lack one or two of the magnetic elements as they have been generally established for the investigation of local disturbance or when time was insufficient for complete observations.

Of the 78 C. I. W. secular-variation stations, *i. e.*, stations where data have been obtained previously by the Department of Terrestrial Magnetism, 55 have been exact reoccupations, 11 have been close reoccupations (within less than 30 meters), 8 have been practical reoccupations (within less than 300 meters), and 4 proximate reoccupations (within less than 5 kilometers). It has been possible also to reoccupy approximately during 1911 to 1913 more than 100 points at which the magnetic elements had been observed previously by other organizations or observers; about half of these are reoccupations within 300 meters and the others within 5 kilometers. Thus from about 18 per cent of the stations occupied during 1911-1913 secular-variation and correlation data have been obtained. Twenty-one of the stations have been at magnetic observatories; several of these have been occupied more than once, thus affording desired data regarding the question as to the degree of accuracy within which the instrumental constants can be main-

1

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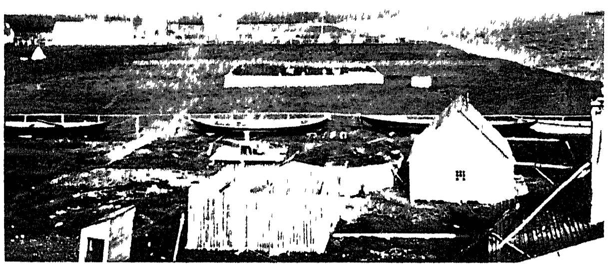

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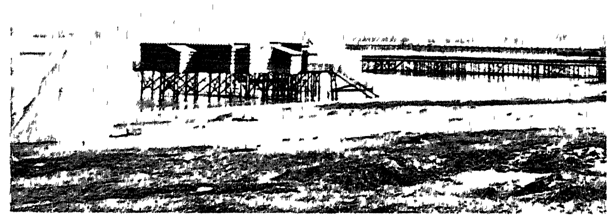

6

Typical Views of Magnetic Expeditions in North and South America.

1 Osnaburgh House, Hudson's Bay Post, Canada
2. Fawcett's Post, Lake St Joseph, Canada.
3. Fort Albany, Hudson Bay
4. Kurupukari Falls, British Guiana
5 Huarnonia, Bolivia
6 Montevideo, Uruguay.

tained under strenuous field conditions. The results of the comparisons of magnetic standards made at these observatories will be found in a subsequent section.

The Department of Terrestrial Magnetism has continued to furnish instrumental and other assistance in cooperation with various organizations and in particular with expeditions to polar regions. The Australasian Antarctic Expedition of 1911 to 1913 was supplied with two magnetic outfits and two observers were trained in the observational work. There has thus been obtained the very valuable series of observations in the Victoria Quadrant to be found in the Table of Results. The Department likewise instructed the observer-in-charge of the magnetic work of the Crocker Land Expedition, which set out in 1913 under the auspices of the American Museum of Natural History and the American Geographical Society, with the cooperation of the University of Illinois; two magnetometers, a dip circle, and accessories, instrumental constants, and program with directions for proposed work were supplied the expedition.

TABLE 5.—*Summary showing the Geographical Distribution of Magnetic Stations, 1911–1913.*

Countries and subdivisions	No. of stations: Primary	No. of stations: Secondary	C. I. W. repeat stations	Totals by country
Africa	. .	. . .	. . . .	207
Algeria	22		2	
Algerian Sahara	61	23	.	
Anglo-Egyptian Sudan	2	. . .	. .	
British South and Central Africa	4	.	.	
Egypt	4	1	3	
Eritrea	1		. .	
French West Africa	51	1	1	
Gambia	3	.	1	
Liberia	3	.		
Morocco	13	. .	.	
Nigeria	1			
Portuguese Guinea	2	.		
Rio de Oro	2	.	.	
Sierra Leone	5	.	1	
Tripolitania	2	. . .	1	
Tunisia	6	. . .	. . . . .	
Asia	. . .	. . . .	. . .	83
China	26	2	6	
India	6	. .	3	
Indo-China	28	3	. . . .	
Siam	9	1	. . . .	
Turkish Empire	8	. . .	2	
Australasia	. .	. . . .	. . .	284
Australia	249	33	9	
New Zealand	2	. . .	. . .	
Europe		. .	. . .	38
Bulgaria	4	. .	.	
Crete	1	. .	. . . .	
Great Britain	7	.	4	
Greece	6	. .	. .	
Italy	9	. . .	4	
Malta	1	. . .	. . .	
Serbia	1	. . . . .	. . . .	
Spain	2	. . . .	1	
Turkish Empire	7	. . . .	1	
North America	.	.	.	48
Canada	38	.	2	
Central America	2		2	
United States[1]	8		3	
South America			. .	247
Argentina	20	2	4	
Bolivia	12	.	2	
Brazil	52	.	3	
Chile	27	1	. .	
Colombia	1		. .	
Ecuador	1	1	1	
Guiana	8	.	3	
Paraguay	12	.	.	
Peru	60	3	7	
Uruguay	11	. . . .	.	
Venezuela	36	.	2	
Islands Atlantic Ocean	. .		. . .	16
Canary Islands	6	. . .	1	
Falkland Islands	3	. . . . .	. . .	
St. Helena	5	. . .	1	
West Indies	2	. . . . .	1	
Islands Indian Ocean	. . .	. . .	. . .	14
Ceylon	4	. .	. . .	
Java	2	4	.	
Mauritius	3	1	.	
Islands Pacific Ocean	.	.	. .	16
Fiji Islands	2		2	
Macquarie Island	2	3		
Philippine Islands	3	. . .		
Samoan Islands	3	. . .	.	
Society Islands	3	. . . .	3	
Antarctic Regions		.	.	30
Victoria Quadrant	30	. .	2	
Grand total	.	. . .	. . . . .	983

[1]No account is taken here of the numerous observations at Washington, D. C., in connection with the determinations of constants and the standardization of instruments.

RESULTS OF LAND MAGNETIC OBSERVATIONS, 1911–1913.

AFRICA.

ALGERIA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor. Intensity: L. M T	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Philippeville	36 53 0 N	6 54	Dec 24,'11	13 4, 15 1	10 28 5 W			13 9, 14 7	25613	7		WHS
			Dec 25, 11			11 2	52 30 2 N				202 1257	WHS
Algiers, *M*.	36 48 1 N	3 02	Jan 4, 12	10 1 to 13 7(6)	11 44 7 W			14 8, 15 6	.25423	7		WHS
			Jan 5, 12	13 7 to 14 5(4)	11 43 2 W			9 5, 10 3	.25416	7		WHS
			Jan 5, 12	14 8 to 16 2(4)	11 43 2 W			11 3, 12 1	25424	7		WHS
			Jan 6, 12			10.1, 15 6	53 00 0 N				202 12	WHS
			Jan 7, 12			10.4	53 02 0 N				202 12	WHS
			Jan 9, 12			10.2	53 03 0 N				202 12	WHS
			Oct 10, 12	11 2, 16 4	11 36 6 W					13		DWB
			Oct 10, 12	11 3 to 16 2(dv)	11 38 5 W					13		DWB
			Oct 11, 12			16 7	53 02 4 N	12 2, 13 6	25434	13	223 13	DWB
			Oct 13, 12			13 9	52 59 6 N				223 56	DWB
			Nov 30, 12	10 8 to 12 0(4)	11 38 4 W			14 7, 15 5	25415	7		WHS
			Dec 3, 12					9 9, 10 8	25407	7		WHS
			Dec 3, 12					14 2	25404	7		WHS
			Dec 4, 12			10 2, 11 6	52 57.2 N				202 12	WHS
			Dec 5, 12	9 7, 10 0	11 35 4 W			10 9, 12 0	25424	7		WHS
			Dec 5, 12					13 9	25403	7		WHS
Algiers, *O*	36 48 1 N	3 02	Jan 9, 12			12 0	53 01 0 N				202 12	WHS
			Jan 9, 12			15 0, 16 2	53 00 4 N				202 12	WHS
			Jan 11, 12	9 2, 9 5	11 45 8 W			11 4, 12 2	25428	7		WHS
			Jan 11, 12	9 8, 10 1	11 46 7 W			14.2, 15 1	25440	7		WHS
			Jan 11, 12	10 3, 10 7	11 47 2 W			16 0, 16 7	25428	7		WHS
			Jan 12, 12	10 1 to 12 2(5)	11 48 3 W					7		WHS
			Jan 13, 12					9 8, 10 6	25392	7		WHS
			Oct 10, 12	11 5 to 16 4(dv)	11 42 5 W					7		WHS
			Oct 11, 12					11 7, 12 6	25444	7		WHS
			Oct 13, 12			13.3	52 56 6 N				202 1257	WHS
			Dec 4, 12			14 7	52 56 3 N				202 12	WHS
			Dec 4, 12			15.7	53 00 4 N				202 1	WHS
			Dec 6, 12	11 4 to 14 6(6)	11 39 0 W					7		WHS
			Dec 7, 12					11 5, 14 0	25426	7		WHS
			Dec 9, 12	14.4, 14 8, 15 2	11 38 9 W			10 5, 11 3	25424	7		WHS
			Dec 10, 12					10 3, 11 2	25438	7		WHS
			Dec 10. 12					14 2	.25434	7		WHS
Algiers, M_2.	36 48 1 N	3 02	Oct 10, 12	10 8, 16 4	11 38 0 W					20		HES
			Oct 10, 12	11 2 to 16 2(dv)	11 40 7 W					20		HES
			Oct 11, 12	14.1	11 42 4 W					20		HES
			Oct 12, 12					9 9, 12 4	25403	20		HES
			Oct 13, 12			14 2	53 02 3 N				20 1256	HES
Bougie...	36 45 0 N	5 05	Dec 28, 11	12.9, 14 6	10 55 2 W			13 3, 14 2	25378	7		WHS
			Dec 29, 11			10 3	52 46 0 N				202 1257	WHS
Souk-Ahras	36 17.7 N	7 58	Dec 17, 11	10 2, 11 6	10 04 6 W	14 3	51 43 1 N	10 6, 11 3	.25882	7	202 12	WHS
Setif	36 11.8 N	5 22	Dec 27, 11	10 0, 11 6	10 57 4 W	14 1	51 57.6 N	10 4, 11 2	.25774	7	202 12	WHS
Orleansville.	36 09 9 N	1 21	Jan 28, 12	13 3, 15 0	12 26 4 W			13 8, 14 6	.25510	7		WHS
			Jan 29, 12			10 3	52 40 0 N				202 12	WHS
El-Guerrah...	36 08 5 N	6 36	Dec 19, 11	9.6, 11 1	10 29 5 W	13 8	51 43 3 N	10.0, 10 7	.25894	7	202 12	WHS
Oran (new station)	35 44 6 N	359 24	Mar 1, 12	10 4, 12 0	13 06 4 W	14 4	52 20.0 N	10 9, 11 6	25734	7	202 12	WHS
Oran (Gambetta)	35 43.1 N	359 23	Feb 27, 12	14 3, 16 4	13 06 6 W			14 9, 16 0	.25748	7		WHS
			Feb 28, 12			9 6	52 15 7 N				202 1257	WHS
Tiaret	35 22.1 N	1 19	Feb 5, 12	9 9, 11 6	12 14 6 W	14 8	51 34 1 N	10 4, 11.2	25933	7	202 12	WHS
Nemours	35 05 8 N	358 15	Mar 9, 12	10 2, 11 9	13 33 5 W	14.6	51 52 0 N	10 7, 11 5	25842	7	202 12	WHS
			Mar 10, 12			14 2	51 53 6 N				202 5	WHS
Biskra..	34 51 0 N	5 44	Dec 21, 11	9 5, 11 2	10 44 8 W	14 2	50 15 9 N	9 9, 10 8	.26368	7	202 12	WHS
Saida .	34 50 2 N	0 09	Feb 11 12	9 8, 11 3	12 51 7 W	14 5	51 16 6 N	10 2, 10 9	26000	7	202 1257	WHS
Bedeau	34 30 2 N	359 11	Feb 7, 12			16 6	51 03 9 N				202 12	WHS
			Feb 8, 12	9 7, 11 5	12 53 8 W			10 2, 11 1	26089	7		WHS
Le Kreider	34 09.1 N	0 06	Feb 13, 12	9.7, 11 6	12 30 4 W	14 4	50 12 0 N	10.3, 11 2	26488	7	202 12	WHS
			Feb 14, 12			8 7	50 11 6 N				202 57	WHS
Ain Sefra	32 45.7 N	359 26	Feb 15, 12	10 2, 11 6	12 41 4 W	14 6	48 35 9 N	10 6, 11 3	26961	7	202 1257	WHS
Beni-Ounif	32 02 6 N	358 45	Feb 21, 12	9 2, 10 9	12 51 9 W	15 1	47 53 6 N	9 6, 10 5	27197	7	202 1257	WHS
Colomb-Bechar	31 37.2 N	357 48	Feb 18, 12	9 6, 11 4	13 08 4 W	14 6	47 37 3 N	10 2, 11 1	27278	7	202 1257	WHS

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ALGERIAN SAHARA.

Station	Latitude	Long East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Steil, *A*	34 15 2 N	5 54	Oct 31,'12	14 5, 17.4	10 37 8 W			15 4, 16 8	26676	13		DWB
			Nov 1, 12			10.5	49 25 2 N				223 13	DWB
Steil, *B*	34 15 2 N	5 54	Oct 31, 12			16 0	49 30 4 N				20 126	HES
			Nov 1, 12					10 5	.26685	20		HES
Berzique	33 42 9 N	5 58	Nov 3, 12	13 5, 16 2	10 27.2 W	21 6	48 50 8 N	14 4, 15 6	.26868	13	223 56	DWB
Berzique, Secondary	33 42 9 N	5 58	Nov 3, 12			15 1	48 51.9 N				223 13	HES
Touggourt	33 07 8 N	6 05	Nov 6, 12	11 2	10 23 1 W	15 4	47 56 6 N	9 6, 10 6	.27366	20	223 13	HES
Hassi Mahmar	32 33 7 N	5 38	Nov 9, 12	10 6, 13 2	10 23 8 W	15 4	47 12 6 N	11.4, 12.7	.27489	13	223 13	DWB
El Bour N'Goussa, *A*	32 10 N	5 20	Nov 11, 12	13 9, 16 5	10 32.8 W			14 7, 15.9	27565	13		DWB
El Bour N'Goussa, *B*	32 10 N	5 20	Nov 11, 12	16 4	10 31 4 W	14 2	46 54 5 N			20	223 13	HES
Ouargla	31 57 7 N	5 20	Nov 13, 12	10 7, 16 8	10 32 0 W			13 3, 14 8	.27734	20		HES
			Nov 14, 12			10 4	46 33 0 N				223.13	HES
			Nov 19, 12	13 4, 16 4	10 33 4 W			14.4, 15 6	27746	13		DWB
			Nov 20, 12			1 5	46 36 4 N				223 56	DWB
Er-el-Aisha	31 47.7 N	5 06	Nov 20, 12	15 9	10 22 1 W			16 6	.27828	13		DWB
Hassi Metalla	31 39 3 N	4 59	Nov 21, 12	14 2, 16 8	10 30 1 W	21 8	46 06 3 N	14 8, 16 0	27850	13	223 1	DWB
Hassi-el-Hadjar, *A*	31 27 7 N	4 47	Nov 22, 12	15 7	10 33 3 W					20		HES
			Nov 23, 12	9 3, 12 4	10 31 4 W	16 3	45 54 4 N	10 2, 11 6	.27907	20	223 13	HES
Hassi-el-Hadjar, *B*	31 27 7 N	4 47	Nov 23, 12	13.8, 16 1	10 31 3 W			14 4, 15 5	.27878	13		DWB
Jarf-el-Bacra	31 03 6 N	4 04	Nov 26, 12	13 5, 16 5	10 50 2 W			14 1, 15.2	28027	13		DWB
			Nov 27, 12			7 6	45 19 7 N				223 56	DWB
Jarf-el-Bacra, Secondary	31 03.6 N	4 04	Nov 26, 12			15.0	45 20.0 N				223 13	HES
Arec Kanem	30 46 2 N	3 15	Nov 29, 12	14 6, 16 4	10 04 8 W					20		DWB
			Nov 30, 12					8.0, 9 3	28118	20		DWB
Arec Kanem, Secondary	30 46 2 N	3 15	Nov 29, 12			15 9	45 06 6 N				223 13	HES
El-Golea	30 34 9 N	2 53	Dec 1, 12	11 1, 16 0	11 12.9 W			14 1	.28165	13		DWB
			Dec 2, 12	7.6	11 11 2 W	13 5	44 52 7 N	8 7, 9 8	.28184	13	223 136	B&S
Camp 2 from El-Golea	30 15 2 N	2 59	Dec 4, 12	13 8	10 08 7 W			15 2	28285	20		HES
Camp 2 from El-Golea, Secondary	30 15 2 N	2 59	Dec 4, 12			16 6	44 26 6 N				223 13	DWB
Grun-el-Dehia	30 05 6 N	3 00	Dec 5, 12	13 8, 16 7	11 11 0 W			14 5, 15 6	28419	13		DWB
			Dec 6, 12			8 0	44 08 1 N				223 56	DWB
Hassi-el-Meksa	29 54 0 N	3 02	Dec 6, 12	15 8	11 06 3 W			16 6	.28479	20		HES
Hassi-el-Meksa, Secondary	29 54 0 N	3 02	Dec 6, 12			16 5, 17 2	43 50.2 N				223 13	DWB
Camp 5 from El-Golea	29 34 8 N	3 00	Dec 7, 12	16 6, 16.9	11 02 0 W					20		HES
Fort Miribel	29 25 9 N	3 01	Dec 8, 12	14 2, 17 0	11 03 3 W			14 8, 15 8	28630	13		DWB
			Dec 9, 12			7.6	43 07.3 N				223 13	DWB
Dait Seddeur	29 17 2 N	3 01	Dec 9, 12	12 9, 16.3	11 04 2 W			14 0, 15 1	.28746	20		HES
Dait Seddeur, Secondary	29 17 2 N	3 01	Dec 9, 12			15 8, 16 5	42 55 6 N				223 56	DWB
Tabaloulet	29 05 2 N	3 00	Dec 10, 12	13 8, 16.5	11 03 6 W			14 4, 14 7	.28802	20		HES
Tabaloulet, Secondary	29 05 2 N	3 00	Dec 10, 12			15 5	42 35 9 N				223 56	DWB
Dinissi	28 56 1 N	3 04	Dec 11, 12	13 8	11 02 6 W			14 7, 16.7	28827	13		DWB
			Dec 12, 12	9 6	11 00 7 W	7 8	42 25.4 N			13	223 13	DWB
Tilmas Ferkla	28 34.3 N	3 07	Dec 13, 12	10 4, 13.0	10 50 5 W	16 8	41 56 4 N	11 2, 12 3	.29022	20	223 13	HES
Camp 5 from Fort Miribel	28 24.1 N	3 10	Dec 14, 12	15 9, 16 2	10 50 9 W					13		DWB
Camp 5 from Fort Miribel, Secondary	28 24.1 N	3 10	Dec 14, 12			15.2	41 32 3 N				223 13	HES
Mousa-ben-Yaich	28 13 0 N	3 12	Dec 16, 12	13.4, 15.8	10 51 0 W			14 1, 15.2	29136	13		DWB
			Dec 17, 12			8 6	41 18.9 N				223 13	DWB
Camp 7 from Fort Miribel	28 00 6 N	3 10	Dec 19, 12	16 8	10 49 8 W					20		HES
Gouiret-ed-Diab	27 49 6 N	3 02	Dec 20, 12	14 1, 17.6	10 54 3 W			16.3, 17.1	29299	20		HES
			Dec 21, 12	10 2, 14.7	10 54.4 W			11 0, 13 8	.29300	20		HES
Gouiret-ed-Diab, Secondary	27 49 6 N	3 02	Dec 20, 12			15 9	40 39 2 N				223 56	DWB
Foggaret-ez-Zoua	27 21 5 N	2 52	Dec 23, 12	9 5, 11.8	11 08 8 W			10 2, 11 3	29529	13		DWB
Foggaret-ez-Zoua, Secondary	27 21 5 N	2 52	Dec 23, 12			10 3	40 07.0 N				223 13	HES
In-Salah	27 12 3 N	2 30	Dec 29, 12	15 3	11 10 5 W	12 4	39 38 5 N			13	223 13	DWB
			Dec 30, 12	14 7	11 11 4 W			11 2, 12 4	.29522	13		DWB
			Dec 30, 12	14.9 to								
			Dec 31, 12	14 7 (dv)	11 08 5 W					13		DWB
			Dec 31, 12	15 0	11 10 2 W					13		DWB
Camp 2 from In-Salah	26 46 9 N	2 48	Jan 3, 13	16 5	11 09 8 W	16 7	38 55 4 N	17 2	.29675	20	223 1	B&S
Hassi-el-Khenig	26 30 6 N	3 03	Jan 4, 13					22 9	.29756	13		DWB
			Jan 5, 13	7 1, 7.3	11 03 6 W	2 9	38 33 8 N	0 3	29767	13	223 56	DWB
Camp 4 from In-Salah	26 15 7 N	3 27	Jan 5, 13	17 0	10 54.0 W	20 8	38 05 6 N			20	223 13	HES
In-Belrem[1]	26 00 N	3 00	Jan 6, 13			17 0	37 38 4 N	15 6, 17 0	.30023	20	223 5	B&S
Oued Tibrad	25 54 6 N	3 15	Jan 7, 13	12 3, 14.4	10 57 8 W	17 1	37 20 1 N	12 8, 13 8	30010	13	223 13	DWB
Takoubaret	25 45.1 N	3 25	Jan 9, 13	15 1, 17.1	11 05 6 W			16 2	.30279	20		HES
			Jan 10, 13	9 5, 14.0	11 05 5 W	16.1	37 10 2 N	10 3, 11.2	.30285	20	20.1	HES

[1]The magnetometer and dip-circle stations are about 60 meters apart.

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ALGERIAN SAHARA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M. T.	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Takoubaret, Auxiliary	25 45 1 N	3 25	Jan 9,'13			16 7	37 06 0 N				223 56	DWB
Camp 8 from In-Salah[1]	25 38 3 N	3 32	Jan 12, 13	14 1, 17 1	11 22 6 W	15 2	36 48 2 N	14 8, 15 8	30178	13	223 13	B&S
Camp 9 from In-Salah[1]	25 30 7 N	3 32	Jan 13, 13	13 2, 15 9	10 35 8 W	13 9	36 26 2 N	13 9, 15 2	30255	20	223 56	B&S
Camp 10 from In-Salah	25 20 4 N	3 37	Jan 14, 13	13 6, 15 6	10 56 8 W	17 2	36 23 4 N	14 1, 15 1	30202	13	223 13	B&S
Taoun Tarak	25 15 8 N	3 45	Jan 15, 13	12 8, 15.2	11 08 4 W	16 9	36 08 9 N	13 6, 14 7	30338	20	223 56	B&S
Camp 12 from In-Salah[1]	25 11 1 N	3 52	Jan 16, 13	13 2, 15 6	10 24 4 W	16 0	35 55 4 N	13 9, 15 1	30488	20	223 13	B&S
Hassi Meniet	25 01 8 N	4 19	Jan 18, 13	9 8, 16 9	11 04 8 W	15 0	35 30 7 N	10 4, 11 4	30584	13	223 13	DWB
Tesnou	24 43 1 N	4 39	Jan 20, 13	14 5, 16 9	10 18 0 W			15 2, 16 1	30572	20		HES
			Jan 21, 13			15 0	34 51 8 N	9 8, 11 0	30578	20	20 12	HES
Camp 16 from In-Salah	24 34 3 N	4 46	Jan 22, 13	13 4, 17 3	10 20 3 W			15 0, 16 0	30488	13		DWB
Camp 17 from In-Salah[1]	24 27 5 N	4 52	Jan 23, 13	13 8, 15 8	10 05 2 W	16 3	34 34 6 N	14 4, 15 3	30627	20	223 13	B&S
Camp 18 from In-Salah	24 14 3 N	4 50	Jan 24, 13	14.2, 16 2	10 15 4 W			14 8, 15 7	30795	13		DWB
			Jan 25, 13			10 1	34 01 6 N				223.56	DWB
			Jan 26, 13	10 2	10 16 1 W					13		DWB
			Jan 26, 13	12 6 to								
			Jan 27, 13	12 6(dv)	10 14 0 W					13		DWB
			Jan 27, 13	12 7	10 17.2 W					13		DWB
Camp 18 from In-Salah, Auxiliary	24 14 3 N	4 50	Jan 24, 13			17 3	34 05 3 N				20 12	HES
Camp 19 from In-Salah[1]	24 00 N	5 04	Jan 28, 13	17 4	10 32 6 W	17 2	33 41 8 N			20	223 1	B&S
In-Amguel	23 41 3 N	5 08	Jan 30, 13	9 8, 11 7	10 27.1 W	15 6	32 51 9 N	10 4, 11 3	30882	20	20 12	HES
Camp 21 from In-Salah[1]	23 35 N	5 03	Jan 31, 13	16 0	10 43 3 W	16 1	32 58 6 N	16 5	31023	13	223 13	B&S
Tit	22 58 0 N	5 09	Feb 3, 13	9 9, 12 9	10 28 8 W	16 2	31 44 4 N	10 9, 12 3	31209	13	223 13	DWB
Tit, Auxiliary	22 58 0 N	5 09	Feb 3, 13			17 4	31 45 6 N				20 12	HES
Tamanrasset	22 47 0 N	5 28	Feb 5, 13	9 7, 14 2	10 39 4 W	15 4	31 04 6 N	10 8, 11 6	31374	20	20 12	HES
Fort Motylinski	22 40 6 N	5 49	Feb 11, 13	9 9, 15 0	10 05 4 W	16 3	30 52 5 N	10 6, 11 6	31341	20	20 12	DWB
Talanteidi	22 38 0 N	5 28	Feb 15, 13	13 2, 15 5	10 21 2 W	17 3	30 48 6 N	14 0, 15 0	31214	20	20 12	HES
Camp 27 from In-Salah	22 31 5 N	5 20	Feb 16, 13	13 4	10 36 0 W	17 2	30 55 0 N	14 0, 15 0	31276	13	223 13	DWB
Tegueneouen	22 19 N	4 56	Feb 17, 13	17.2	10 36.5 W			17.6	31468	20		HES
Hassi Amalaouly	22 18 9 N	5 01	Feb 18, 13	15 6	11 10 7 W					13		DWB
			Feb 19, 13	11 3	11 04 4 W	14 8	30 41 2 N	9 7, 10 7	31720	13	223 56	DWB
Amselkat	22 08 5 N	4 49	Feb 21, 13	11 8, 16 0, 17 2	10 33.9 W	16 1	30 20 5 N	10 4, 11 3	31520	20	20 12	HES
Camp 31 from In-Salah	22 00 N	4 43	Feb 26, 13	14.0, 16 2	10 32.0 W			14 6, 15 7	31440	13		DWB
Camp 32 from In-Salah	21 36 N	4 35	Feb 27, 13	17.2	10 21 4 W	17.8	29 29 1 N			20	20 1	HES
Camp 33 from In-Salah	21 29 5 N	4 36	Feb 28, 13	13 5, 15 6	10 41 6 W	17.4	28 57 3 N	14 1, 15 1	31567	13	223 13	DWB
Camp 35 from In-Salah	21 01 4 N	4 11	Mar 2, 13	13.5, 15 6	10 38 1 W	17 6	28 02.8 N	14 1, 15 2	31564	13	223 13	DWB
Camp 38 from In-Salah	20 28.5 N	3 28	Mar 6, 13	13.8, 15 6	11 08 5 W	17 2	27 14 2 N	14 4, 15 3	31706	13	223 13	B&S
Tadeini	20 15 4 N	3 11	Mar 8, 13	13.9, 16 7	11 25.2 W			15 0, 16 2	31857	20		HES
			Mar 9, 13			8 6	27 04 7 N				20 12	HES
			Mar 9, 13			9 9	27 04 0 N				20 6	HES
Camp 44 from In-Salah	19 57.3 N	2 34	Mar 14, 13	13.9, 16 0	11 14 9 W	17 6	26 15 6 N	14 6, 15 6	31646	20	20 12	HES
Tin-Zaouaten	19 57 1 N	2 50	Mar 11, 13	14 0, 16 1	11 15 2 W			14 8, 15 7	31761	13		DWB
			Mar 12, 13			16 8	26 25 5 N				223 13	DWB

ANGLO-EGYPTIAN SUDAN

Station	Latitude	Long East of Gr	Date	Decl. Local Mean Time	Decl. Value	Incl. L M. T.	Incl. Value	Hor Int. L M T	Hor Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Port Sudan	19 37 2 N	37 12	Apr 13,'11	9 0, 11.0	2 16 9 W	14 3	21 25 8 N	9 7, 10 6	34049	7	202 1256	WHS
Suakin	19 06.7 N	37 20	Apr 15, 11	9 2, 11 3	1 51 0 W	14 4	20 21 5 N	9 8, 10 8	34254	7	202 1256	WHS

BRITISH SOUTH AND CENTRAL AFRICA.

Station	Latitude	Long East of Gr	Date	Decl. Local Mean Time	Decl. Value	Incl. L M. T.	Incl. Value	Hor Int. L M T	Hor Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Cape Town, *A.*	33 56 8 S	18 29	Mar 24,'11	10 2, 12 2, 14 2	27 38 0 W			10 9, 11 7	17576	4		C II
			Mar 24, 11	15 8, 17 4	27 35 4 W			14 7, 15.4	17570	4		C II
			Mar 24, 11					16 3, 16 9	.17582	4		C II
			Mar 25, 11	9 0, 11 0	27 38 6 W			9 6, 10 5	17595	2		C II
			Mar 25, 11	12.2, 14 0	27 35 7 W			12 7, 13 5	17585	2		C II
			Mar 27, 11	9.6, 12 4	27 36 5 W			10 2, 11 4	17594	2		C II
			Mar 27, 11	13 2, 15 6	27 34 7 W			13 8, 15 0	17577	2		C II
			Apr 3, 11			14 1, 14 7	60 07 6 S				EI 2	C II
			Apr 4, 11			9 5, 10 2	60 04 7 S				201 12	C II
			Apr 4, 11			10 6, 11.0	60 04 6 S				201 12	C II

[1]For these the magnetometer and dip-circle stations are about 60 meters apart

AFRICA.

BRITISH SOUTH AND CENTRAL AFRICA—*Concluded*

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T.	Inclination: Value	Hor Intensity: L. M. T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Cape Town, *A*—*Continued*	33 56 8 S	18 29	Apr 18,'11	12.8, 13 3 .	27 33 7 W			.	.	4		C II
			Apr 18, 11	13 8, 15 5 .	27 34 2 W			.	. .	4	.	C II
Cape Town, *B*	33 56 8 S	18 29	Mar 25, 11	9 0, 11 0	27 38 9 W		.	9 6, 10.6	17611	8	.	C II
			Mar 25, 11	12 2, 14 0 .	27 35 6 W		.	12 7, 13.5	.17584	8	. .	C II
			Mar 27, 11	9.6, 12 4	27 36 8 W	.		10 2, 11.4	.17595	4	. .	C II
			Mar 27, 11	13 2, 15 6	27 35 4 W	. .	. .	13 9, 15.0	17576	4	. .	C II
			Mar 28, 11	12.8, 16 0 .	27 35.5 W	. .	.	14.5 .	17586	8	. .	C II
			Mar 29, 11	11.2, 15 1	27 38 2 W	. ..	. .	13 5	17596	8	. .	C II
			Mar 30, 11	9.9, 16 6 ..	27 37 1 W	.	.	14 9, 16.0	17621	8	. . .	C II
			Apr 3, 11	. . .	.	10 2, 11.5	60 03 3 S		..	.	201 12	C II
			Apr 3, 11	. . . .	.	13 3, 14 2	60 05 4 S	.	.		201 12	C II
			Apr 4, 11	. .		9 6, 10 2	60 04 4 S	.	.		EI 2	C II
			Apr 4, 11	.		11 0, 12 8	60 04 6 S		..		EI 2	C II
			Apr 4, 11	. . . . .		14 2	60 05 1 S	. ...	.	. ..	EI 2	C II
			Apr 5, 11	.		10 7, 11 9	60 05 0 S		..		EI 2	C II
			Apr 5, 11	. .		13 2, 13 9	60 04 6 S		. .	.	EI 2	C II
			Apr 5, 11	.		15 1 .	60 04 8 S		.	.	EI 2	C II
Cape Town, *C*	33 56 8 S	18 29	Mar 24, 11	10 2, 12 2, 14 2	27 39 2 W			10 8, 11 6	.17604	2	.	C II
			Mar 24, 11	15 8, 17 4	27 37 6 W		.	14 7, 15 4	.17596	2		C II
			Mar 24, 11	. . .				16 3, 16 9	17602	2	. .	C II
			Mar 25, 11	9.0, 11 0	27 43 1 W		. .	9 6, 10 6	17596	4		C II
			Mar 25, 11	12 2, 14 0	27 40 4 W			12 7, 13 6	17590	4	. ...	C II
			Mar 27, 11	9 6, 12 4	27 41 2 W	. . .	. . .	10 3, 11 4	17602	8	.. ..	C II
			Mar 27, 11	13.2, 15 6	27 39 4 W	.	. . .	13 9, 15 0	17586	8	.	C II
			Mar 31, 11	9 8, 13 8	27 41 0 W	. .		11 6, 12 6	17624	8	. .. ..	C II
			Mar 31, 11	14 5, 16 6	27 37 0 W	..	.	15 2, 16 1	17619	8	.	C II
			Apr 3, 11	. . .	..	11 2 .	60 02 8 S	. . .	. . .	. . .	172 156	C II
			Apr 3, 11	. .	..	14 2 .	60 02 9 S	.... .	.	. .	172.256	C II
			Apr 6, 11		.	10 9, 11 6	60 04 8 S	. . . .	. .	.	EI 2	C II
			Apr 6, 11	.		15 6	60 03 9 S	. .	.		EI 2	C II
Cape Town, *D* . . .	33 56 8 S	18 29	Mar 24, 11	10 2, 12 2, 14 2	27 38 4 W			10 9, 11.7	.17571	8	. ...	C II
			Mar 24, 11	15 8, 17 4	27 35 2 W		. .	14 7, 15 4	.17563	8	.	C II
			Mar 24, 11				..	16 3, 16 9	17582	8	.. . .	C II
			Apr 4, 11	.		9 6	60 01 3 S			.	172.16	C II
			Apr 4, 11	. .		12 9	60 01 6 S		. .		172 55	C II
			Apr 4, 11			14 5	60 03 3 S		. . .		172 16	C II
			Apr 6, 11	. .	. .	14 1 .	60 03 2 S		.	. .	172 56	C II

EGYPT.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T.	Inclination: Value	Hor Intensity: L. M. T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Suez . . .	29 57 8 N	32 33	May 11,'11	8 7, 10 6, 10.9	2 22 0 W	14.1 .	40 40.6 N	9 2, 10.2	30200	7	202 1256	WHS
Helwan Observatory, *N* .	29 51 6 N	31 20	May 23, 11	9 3, 11 5	2 34 0 W	. .	. .	9 8, 10.6	.30042	7	. .	WHS
				. ...	. ....	. .	.	12 4, 13.2	30048	7	..	WHS
			May 24, 11	9.0, 9 3, 9.5	2 32.0 W	. .	.	10.7, 11.8	.30051	7	.... .	WHS
				10.2, 12 5 ..	2 34.2 W	. .	.. .	. . .		7	. .	WHS
Helwan Observatory, *H* . .	29 51 6 N	31 20	May 17, 11	10 2, 12 5 ..	2 36 6 W	. .	.. .	10 8, 12.0	30028	7	.	WHS
			May 18, 11	8 8, 10 6, 12 3	2 34 5 W	.. .	. . .	9 2, 10.2	30017	7	. ..	WHS
			May 18, 11	12.7, 14.8 . .	2 35 8 W	. .	.. . ..	15 4, 16.3	30018	7	..	WHS
			May 20, 11	.. ..	.. .	10 9, 12 6	40 39 6 N	. . .	. . ..	.. .	202.1256	WHS
			May 21, 11	.. . . .		9 0, 10.3	40 40.2 N		.	.. .	202 1256	WHS
Helwan Observatory, *S* .	29 51 6 N	31 20	May 21, 11	.		12 6 .	40 43.9 N	. .	...	. ..	202 1256	WHS
			May 22, 11			9 4, 11.2	40 43.2 N	.. .	.	. .	202 1256	WHS
Tor	28 14 4 N	33 36	May 8, 11	9 4, 11 3	2 03 2 W	13 6	37 52 8 N	10 0, 10 9	.31004	7	202 12	WHS

ERITREA

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T.	Inclination: Value	Hor Intensity: L. M. T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Massawa	15 35 8 N	39 27	Apr 6,'11	8 6, 10 6	1 48 8 W	14 4 .	12 42 0 N	9 2, 10.2	34834	7	202.1256	WHS

AFRICA.

FRENCH WEST AFRICA.

Station	Latitude	Long East of Gr.	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Cape Blanco	20 48 5 N	342 58	Jul 15,'12	12 1, 13.8	17 59 2 W	15.8	37 21.5 N	12 6, 13 5	.29522	7	202.125	WHS
Hassi Bou-Ghassa	20 01.8 N	2 08	Mar 16, 13	15.0, 17.1	11 59 5 W	...	...	15 7, 16 6	31170	13	...	DWB
			Mar 17, 13	...	...	7.6	28 04 2 N	...	...		223 13	DWB
Camp 48 from In-Salah	19 41 6 N	1 55	Mar 18, 13	13 6, 17 0	11 30 5 W	17.6	25 57 7 N	14 2, 15 5	31770	20	20 12	HES
Hassi Yerlick (Arhli)	19 02 1 N	1 43	Mar 22, 13	8 9, 11.4, 17 0	11 58 0 W	15.4	25 24 8 N	10 0, 11 0	.32175	13	223.13	DWB
Camp 53 from In-Salah	18 49 1 N	1 24	Mar 24, 13	13 3, 16 9	11 55 6 W	...	...	15 0, 16 4	31942	13		DWB
			Mar 25, 13	...	...	10.5	24 46 6 N	...	...	.	223.56	DWB
Portendick	18 26 5 N	343 59	Jul 19, 12	13 4, 15 5	17 45 1 W	...	...	14 0, 15.1	.30200	7	.	WHS
			Jul 20, 12	...	...	11.0	32 57.0 N	.	...	.	202 12	WHS
Kidal	18 25.5 N	1 19	Mar 28, 13	7.6, 9 6	11 52 4 W	10.8	24 11 0 N	8 0, 8 8	32168	20	20 12	HES
Oued Eguerer	18 09 1 N	0 40	Apr 12, 13	13 8, 15.9	12 14 9 W	11.6	23 54 8 N	14 4, 15 4	.31789	13	223 13	DWB
In-Tassik	17 26.2 N	0 03	Apr 16, 13	6.3, 9 9	12 16 4 W	13.5	22 11.1 N	8 3, 9.2	.32016	20	20 12	HES
Bamba	17 00 5 N	358 32	May 2, 13	13 8, 15 9	13 03.0 W	17.3	22 00.0 N	14 5, 15.5	.31960	20	20 1	HES
			May 3, 13	...	...	9.2	22 01.6 N	...	...		20 6	HES
Bourem	16 56 9 N	359 35	Apr 27, 13	9.0, 11.4	12 37.8 W	15.4	21 12 8 N	9 5, 10 8	32141	13	223 13	DWB
Camp 6 from Kidal	16 51 9 N	0 07	Apr 18, 13	8 3, 10 7	12 28.6 W	14 3	20 42 2 N	8 9, 10 1	.32080	13	223.13	DWB
Yoro	16 49 5 N	358 19	May 7, 13	9 1, 11 4	13 24 4 W	16.2	21 45 4 N	9 8, 10 9	.31977	13	223 13	DWB
Timbuktu, *A*	16 46 3 N	356 58	Jul 2, 13	9 0, 11 9	13 40 5 W	...	...	10 1, 11 2	31951	13	...	B&S
			Jul 2, 13	15 0, 17 3	13 41 5 W	...	...	15.6, 16 6	31920	13	...	B&S
			Jul 3, 13	7 1, 9.5	13 37 9 W		...	7 7, 8 9	.31930	13	...	B&S
			Jul 3, 13	12 9, 14 9	13 44 4 W	...	...	13 5, 14.4	.31954	20	...	B&S
			Jul 5, 13	6 5, 8 4	13 39 5 W	...	...	7 0, 8 0	.31926	20	...	B&S
			Jul 5, 13	15 6, 17 9	13 42 8 W	.	.	16 5, 17.4	31922	20	...	B&S
			Jul 7, 13	...	...	8 8, 13 4	22 03.0 N	...	...	..	20 126	B&S
			Jul 8, 13	...	...	7.8	22 03.3 N	...		...	20 126	B&S
			Jul 8, 13	...	...	11.1	22 00 9 N	...	...	..	223 1356	B&S
			Jul 9, 13	...	...	8.1, 10 4	22 03.0 N	...	...	...	223.1356	B&S
			Jul 11, 13	7.7	13 40 3 W	...	...	...	...	20	...	B&S
			Jul 11, 13	7 8 to 12.7 (dv)	13 40.0 W	...	...	...	.	20	...	B&S
			Jul 11, 13	12.9	13 38.2 W	...	...	...	...	20	...	B&S
			Jul 19, 13	12 7, 13 0	13 42.8 W	...	...	...	...	20	...	B&S
			Jul 19, 13	13.1 to 20.3 (dv)	13 42 8 W	...	...	.	...	20	...	B&S
Timbuktu, *B*	16 46.3 N	356 58	Jul 2, 13	9.0, 11.9	13 40 6 W	...	...	10 0, 11.2	.31959	20	.	B&S
			Jul 2, 13	15 0, 17.3	13 41.6 W	...	...	15 5, 16 6	31911	20	...	B&S
			Jul 3, 13	7.1, 9.6	13 37.8 W	...	...	7 7, 8.9	.31940	20	...	B&S
			Jul 3, 13	12.9, 14.9	13 43 5 W	...	...	13.5, 14 4	.31945	13	...	B&S
			Jul 4, 13	6.4, 7 7	13 39.6 W	...	...	7 2, 8 2	.31925	13	...	B&S
			Jul 5, 13	6.5, 8.4	13 40 2 W	...	...	7.1, 8 0	31936	13	...	B&S
			Jul 5, 13	15.6, 17.9	13 42.6 W	...	...	16 5, 17.4	.31921	13	...	B&S
			Jul 7, 13	...	...	9 0, 13 4	22 02 1 N	...	...	.	223 1356	B&S
			Jul 8, 13	...	...	7.8	22 04 0 N	...	...	...	223.1356	B&S
			Jul 8, 13	...	...	11.1	22 01 0 N	...		..	20 126	B&S
			Jul 9, 13	...	...	8 1, 10 4	22 03 4 N	...		.	20.126	B&S
Podor	16 39.4 N	345 03	Oct 12, 13	...	...	15 6	28 39 8 N	...	...	..	20 12	HES
			Oct 13, 13	8 3, 10 7	17 35 6 W	...	...	9 1, 10 3	30725	20	...	HES
Gao	16 16 1 N	359 53	Apr 21, 13	12 8, 14 7	12 41 4 W	16 2	20 03 4 N	13 3, 14.0	31988	20	20 12	HES
Gao, Secondary	16 16 1 N	359 53	Apr 22, 13	17 7, 17 8	12 40 5 W	...	.	.	.	20	..	HES
St. Louis	16 02.9 N	343 34	Jul 26, 12	12 8, 14 7	18 08 4 W	16 8	29 03 3 N	13 4, 14 3	.30577	7	202 125	WHS
Niafunké	15 56.0 N	356 00	Jul 26, 13	7.8, 10.8	14 02 4 W	17 3	20 46 6 N	8 6, 10 2	31870	20	20.126	HES
Ansongo	15 39.7 N	0 26	Aug 2, 13	13 8, 16 3	12 22.6 W	...	...	14 5, 15 7	32401	13	...	DWB
			Aug 3, 13	...	.	13 2	18 20 7 N	...	...	..	223 1356	DWB
Matam	15 39.1 N	346 45	Oct 2, 13	8 2, 10 5	17 29 2 W	16 6	25 51 1 N	8 9, 10 1	31060	20	20 12	HES
Gourao	15 18.3 N	355 59	Jul 30, 13	8 5, 10 4	14 16.8 W	14 5	19 37 2 N	9 0, 9 9	31948	20	20 126	HES
Rapids of Labbezanga	14 57.4 N	0 37	Aug 7, 13	8.6, 10 9	12 33.7 W	15.3	16 43 6 N	9 3, 10 3	.32270	13	223 1356	DWB
Bakel	14 54.3 N	347 33	Sep 26, 13	7 8, 9.9	17 18 0 W	12 8	23 50 4 N	8 5, 9 4	31253	20	20 126	HES
Dakar	14 42.0 N	342 35	Jul 30, 12	13.9, 15.8	18 33 0 W	...	...	14 4, 15 3	30563	7	...	WHS
			Jul 31, 12	...	...	10.2	27 17 0 N	...	.	...	202 125	WHS
			Aug 15, 12	...	...	16 4	27 21 5 N	.	...	...	202 5	WHS
			Nov 26, 13	10 5, 14.2	18 31.2 W	...	...	12 8, 13 7	30600	20	...	HES
			Nov 27, 13	8.8, 8.9	18 27 4 W	10 0	27 00 6 N	.	...	20	20.126	HES
Mopti	14 30.1 N	355 47	Aug 3, 13	8 0, 10.6	14 24 0 W	12 8	17 55 4 N	8 7, 10 1	.31985	20	20 12	HES
Kayes	14 26.9 N	348 34	Sep 16, 13	8.1, 10.8	17 00 8 W	16 3	22 20 0 N	8 8, 10 0	31383	20	20 126	HES
			Sep 20, 13	...	...	...	...	9 0	.31390	20	...	HES
Tillabery	14 12 0 N	1 20	Aug 12, 13	...	...	17.2	14 43 3 N	...	...	...	223 1356	DWB
			Aug 13, 13	9 2, 11.4	12 26 8 W	...	...	9 8, 10.9	.32428	13	...	DWB
Kaolack	14 07.8 N	343 58	Aug 2, 12	8 6, 10 3	18 21.2 W	14.3	24 59 7 N	9 1, 10 0	30854	7	202.125	WHS
Koumpentoum	13 58.4 N	345 30	Aug 7, 12	8 7, 9.4	17 57 8 W	14 3	23 38 7 N	9.2, 10.0	31049	7	202.125	WHS

AFRICA.

FRENCH WEST AFRICA—*Concluded.*

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Keé	13 57.1 N	354 36	Aug 8,'13	13 6, 15.8	14 56.7 W			14 0, 15 3	.31893	20		HES
			Aug 9, 13			10.7	17 22.9 N				20 126	HES
Mahina	13 45 4 N	349 07	Sep 6, 13	7.3, 9.5	16 50 8 W			7 9, 9 0	.31441	20		HES
			Sep 7, 13			16.5	20 34 0 N				20.126	HES
Niamey	13 30.2 N	2 00	Aug 17, 13			17 4	12 55.9 N				223.13	DWB
			Aug 18, 13	9 2, 11 6	12 08 4 W			9 9, 11.1	.32492	13		DWB
Segou	13 26 5 N	353 42	Aug 15, 13	15 4, 17.2	15 17 6 W			15 8, 16 8	.31847	20		HES
			Aug 16, 13			10 3	16 46 8 N				20 12	HES
Say	13 06 9 N	2 16	Aug 20, 13			16 7	11 50.6 N				223.1356	DWB
			Aug 21, 13	13 2, 15 4	12 09 8 W			13 8, 14 9	.32476	13		DWB
Kita	13 02 1 N	350 28	Sep 2, 13	8 4, 10 6	16 30 7 W	15 2	18 01 4 N	9 1, 10 1	.31553	20	20 26	HES
			Sep 3, 13			8 5	18 01 4 N				20 2	HES
Koulikoro	12 51 7 N	352 26	Aug 21, 13	8 8, 10 6	15 57.2 W	15.7	16 25.7 N	9 3, 10 4	.31798	20	20 12	HES
			Aug 22, 13			15.6	16 24 0 N				20 12	HES
Bosia	12 33 3 N	2 40	Aug 25, 13	9 5, 11 8	12 05 6 W	14 5	10 26 6 N	10 1, 11 2	32498	13	223 1356	DWB
Gaya	11 52 5 N	3 22	Aug 30, 13	9 4, 11 6	12 03 0 W			10 0, 11 1	32511	13		DWB
			Aug 31, 13			10 2	8 43.7 N				223 1356	DWB
Goum Goum	11 33 7 N	2 59	Sep 3, 13	9 4, 11 6	12 05.6 W	15 3	8 05 4 N	10 0, 11 1	32430	13	223 1356	DWB
Kandi	11 07 8 N	2 54	Sep 6, 13	8 6, 11 0	12 08 9 W	15.2	7 01 7 N	9 2, 10 4	.32323	13	223 356	DWB
Mamou	10 22 0 N	347 55	Aug 6, 12			14 9	13 16 8 N	13 9, 15 6	28609	13	223 13	DWB
			Aug 7, 12	9 0, 12 1	18 06.9 W			9 8, 11.4	28470	13		DWB
Bambereke	10 13 5 N	2 38	Sep 16, 13	13 6, 16.4	12 36.4 W			14.6, 15 9	.32206	13		DWB
			Sep 17, 13			10 5	5 02.8 N				223 56	DWB
Kindia	10 03.5 N	347 10	Jul 30, 12	13 6, 16.5	18 41 2 W			14.6, 15 9	31148	13		DWB
			Jul 31, 12			13 3	14 57.4 N				223 1356	DWB
			Aug 1, 12	14 7, 17.7	18 41 2 W	11 2	14 57.3 N	15 4, 16.9	.31138	13	223.1356	DWB
Conakry	9 30 6 N	346 16	Jul 23, 12	13 5, 17.2	19 18 5 W			14.7, 16 1	.29663	13		DWB
			Jul 25, 12			15 7	15 22 8 N				223 13	DWB
			Jul 26, 12	9 2, 13 6	19 16 4 W			9 9, 11 2	29670	13		DWB
Paraku	9 21 0 N	2 37	Sep 21, 13	10 5, 8 6	12 48 8 W			9 3, 10 1	32174	13		DWB
			Sep 22, 13			10 4	3 10 3 N				223 1356	DWB
Kilibo	8 34 6 N	2 36	Sep 26, 13	8 3, 10 3	13 02 6 W	16 6	1 26 0 N	8 9, 9 9	32029	13	223 1356	DWB
Savé	8 02 1 N	2 28	Sep 30, 13	8 6, 10 8	13 04 8 W	14.9	0 18 9 N	9 2, 10 3	.31964	13	223 1356	DWB
Bohicon	7 11 3 N	2 04	Oct 2, 13	13 4, 16 1	13 30.9 W			13 9, 14.9	.31680	13		DWB
			Oct 3, 13			9 0	1 22.1 S				223 1356	DWB
Cotonou	6 21 5 N	2 26	Oct 15, 13	9.0	13 32 2 W			9 7, 11 0	.31514	13		DWB
			Oct 16, 13			15 3	3 28 4 S				223.1356	DWB
			Oct 17, 13	17 2	13 32 6 W					13		DWB

GAMBIA.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Bathurst, *A*	13 27 5 N	343 24	Jun 11,'12	14.7, 18.0	18 31 4 W			15.8, 17 3	30689	13		DWB
			Jun 12, 12			14.2	24 50 4 N				223 13	DWB
			Jun 17, 12			16.9	24 54 1 N				223 56	DWB
Bathurst, *B*	13 27 2 N	343 24	Jun 18, 12	8 6, 11 8	18 32 8 W	14 4	24 50 1 N	9.5, 10 8	.30756	13	223 13	DWB
			Nov 30, 13	12 4, 14.2	18 29 0 W	15 0	24 26 5 N	13 0, 13 9	30713	20	20 12	HES

LIBERIA.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Monrovia	6 18 7 N	349 09	Dec 20,'13	13 9, 16 3	18 22.2 W			14 7, 15 8	.30903	20		HES
			Dec 21, 13			8 1	5 09 7 N				20 126	HES
			Dec 26, 13	7 1 to 16 8(dv)	18 21 5 W			9 5, 10 4	.30956	20		HES
Grand Basa	5 52 2 N	349 56	Dec 29, 13	10.3, 11.8	18 07 6 W	13 7	2 39 1 N	10 7, 11 5	.30936	20	20 126	HES
Greenville (Sino)	5 00 6 N	350 55	Dec 31, 13	9 4, 11.6	18 09 1 W			10 1, 11 2	.30868	20		HES
			Jan 2, 14			11 0	1 18 5 N				20 126	HES
			Jan 3, 14	10.5, 12 7	18 08 0 W			11 2, 12 3	.30883	20		HES
			Jan 7, 14	7.3, 9 0	18 07 9 W	12 9	1 18.1 N	7 7, 8.6	30844	20	20 126	HES

AFRICA.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T.	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
MOROCCO.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Tangier, *A*	35 46 2 N	354 08	Apr 5,'12	11.2, 13 9	14 48 9 W			11 9, 13.4	.25188	7		WHS
			Apr 6, 12			11 2, 14 2	53 32 1 N				202 1257	WHS
Tangier, *B*	35 46 2 N	354 08	Apr 5, 12	12 3	14 50 9 W					13		DWB
			Apr 6, 12	10 8	14 48 5 W			12 9	25201	13		DWB
			Apr 7, 12	9 7, 14.4	14 46.8 W			10 8, 12 7	.25189	13		DWB
Melilla	35 17 6 N	357 04	Mar 13, 12	9 7, 11.5	13 48 0 W	14 7	52 11 4 N	10.2, 11.1	.25756	7	202.1257	WHS
Laraish, *A*	35 11.6 N	353 51	May 3, 12	9 2, 11.0	14 47.7 W	14 4	52 55.8 N	9.7, 10.6	.25451	7	202 12	WHS
Laraish, *B*	35 11 6 N	353 51	May 3, 12	9 5, 12 4	14 47 8 W	15.2	52 57.7 N	10.2, 11 0	.25462	13	223.13	DWB
								11.9	.25486	13		DWB
Rabat	34 02 3 N	353 12	May 7, 12			17.1	51 47 2 N				223 13	DWB
			May 8, 12	8 5, 11 4	14 54 3 W	14 8	51 45.4 N	9 6, 10.9	.25926	13	223 56	DWB
Casablanca	33 34 2 N	352 24	May 13, 12	13.8, 16.4	15 09.9 W			14 8, 15 9	.26011	13		DWB
			May 14, 12			10.9, 15.5	51 23.7 N				223 1356	DWB
Mazagan	33 15 7 N	351 30	May 15, 12	14.2, 16.7	15 46 6 W			14 8, 16.0	.26152	13		DWB
			May 16, 12			9 9, 11 4	51 12.1 N				223.1356	DWB
Saffi	32 18.1 N	350 48	May 17, 12	13 6, 16 4	15 31.2 W			14 4, 15 7	.26440	13		DWB
			May 18, 12			9.9, 11.4	50 07 1 N				223.1356	DWB
Mogador	31 31.2 N	350 15	May 23, 12	9 4, 13.1	15 43.0 W			10 1, 11 1	.26699	13		DWB
			May 24, 12			9 1, 11 2	49 22 9 N				223.1356	DWB
			May 29, 12	16.1	15 42 7 W					13		DWB
Cape Nachtigal	28 29 2 N	348 40	Jul 2, 12	9 0, 10 0	16 05 8 W	11 2	45 48 4 N	9 4	27771	7	202 12	WHS
Cape Juby	27 56 0 N	347 04	Jun 13, 12	8 6, 10 4	16 37.7 W	13 4	45 36 2 N	9 1, 10 0	.27852	7	202 12	WHS
Cape Bojador	26 07 5 N	345 31	Jul 5, 12	10 5, 12 6	16 51 9 W	14 7	43 45.4 N	11.2, 12 2	28236	7	202 12	WHS
NIGERIA.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Lagos	6 26.9 N	3 24	Nov 24,'13	15 5	13 06.0 W	12 2	3 41 6 S	16 2, 17 1	31522	13	223 1356	DWB
			Nov 25, 13	10 5	13 05.1 W					13		DWB
PORTUGUESE GUINEA.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Bissao	11 51.5 N	344 26	Dec 11,'13	9 6, 12 6	18 32 1 W	15 4	20 19.1 N	10 2, 11.4	.31237	20	20 126	HES
Bulama	11 35 N	344 33	Dec 14, 13	11 7, 15 7, 16 1	18 31.0 W					20		HES
RIO DE ORO.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Villa Cisneros	23 40.9 N	344 06	Jul 9,'12	9 7, 11 6	17 23 2 W	14 9	41 00 9 N	10 2, 11 2	28896	7	202 257	WHS
Cape Corveiro	21 46 N	343 04	Jul 12, 12	13 4, 14 5	17 58 0 W	16 6	38 45 0 N	13 8	29295	7	202 12	WHS
SIERRA LEONE.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Freetown, 1911	8 29 7 N	346 44	Feb 20,'11			17.3	10 47 2 N				172 125	HFJ
			Feb 21, 11	8 4, 8 8	18 26 6 W			16 8	31247	8		HFJ
Freetown, 1912	8 29.7 N	346 44	Jun 25, 12	15 0, 17 5	81 18 4 W			15 7, 16 9	31334	13		DWB
			Jun 27, 12	13 7, 16.1	18 18 3 W	10 9	10 47 8 N	14 3, 15 5	31315	13	223 13	DWB
Moyamba	8 09 2 N	347 32	Jul 1, 12	8 4, 10 6	17 51 4 W			9 1, 10 2	.31074	13		DWB
			Jul 2, 12			9 7, 11 8	10 53 6 N				223 136	DWB
Baiima	8 01 7 N	349 11	Jul 9, 12	10 9, 14 4	18 15 7 W	16 3	9 10 7 N	12 0, 13 3	.31192	13	223 13	DWB
Bo	7 57.8 N	348 11	Jul 6, 12	10.2, 13 2	18 29 0 W	15 6	9 50 3 N	10 9, 12.2	31160	13	223 13	DWB
TRIPOLITANIA.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Tajura	32 53.2 N	13 22	Dec 21,'13	9 8, 16 2	7 51.7 W	14 9	46 32 6 N	10 3, 11 1	.27764	10	202 1257	WFW
			Dec 22, 13	9 8	7 52 3 W					10		WFW
Tripoli	32 54 N	13 11	Dec 17, 13	11 4, 15.0	7 59 8 W	16 6	46 37 5 N	13 2, 14 0	.27783	10	202 125	WFW
			Dec 18, 13	9 9	7 59 8 W					10		WFW
			Dec 18, 13	13.2 to 15 2(dv)	8 00.7 W					10		WFW
			Dec 18, 13	13 0, 16 2	8 00.5 W					10		WFW

AFRICA.

TUNISIA.

Station	Latitude	Long. East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Tunis	36 46 1 N	10 06	Nov 27,'11	9 8, 11 5	9 20 2 W	14 0	52 01 6 N	10 2, 11 1	.25806	7	202 12	WHS
Susa	35 49 6 N	10 36	Dec 3, 11	9 6, 11 4	9 04 2 W	14 1	50 48 6 N	10 1, 11.0	26261	7	202 12	WHS
Feriana	34 57 1 N	8 37	Dec 13, 11			14.5	49 58 8 N				202 12	WHS
			Dec 14, 11	9 3, 11 2	9 42 1 W	14 0	49 57 5 N	9 8, 10 8	26559	7	202 5	WHS
Sfax	34 43 6 N	10 45	Dec 5, 11	8 4, 10 5	8 56 2 W	13 5	49 22 6 N	9 2, 10 1	26790	7	202 12	WHS
			Dec 9, 11			13 8	49 19 9 N				202 57	WHS
Metlaoui	34 19 0 N	8 28	Dec 12, 11	10 1, 11 6	9 42 5 W	13 8	49 12 6 N	10 5, 11 2	26788	7	202 12	WHS
Houmt-Souk	33 54 6 N	10 59	Dec 7, 11	13 2, 14 9	8 48 0 W			13 6, 14 5	27166	7		WHS
			Dec 8, 11			9 2	48 14 8 N				202 12	WHS

ASIA.

CHINA.[1]

	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Tsinan[2]	36 39 1 N	116 55	Oct 16,'08			14 8, 15 9	53 05 0 N				171 (5678)	CKE
			Oct 17, 08	9.8, 15 5	3 30.4 W			10 3, 14 8	30835	2		CKE
Hwaiyuan An	32 58 0 N	117 11	Sep 5, 11	16 3, 17.9	2 28 3 W	11.4	48 22 0 N	16 9, 17 6	32588	12	206 12(56)	CKE
Wuhu	31 21 1 N	118 20	Sep 1, 11	15 0, 16 1	2 49 6 W	16.9	45 43 6 N	15 3, 15 8	33858	12	206 12(56)	CKE
Soochow	31 20 3 N	120 39	Sep 9, 11	10 8, 12 5	2 40 1 W	17 1	45 47 6 N	14 4, 15 1	33314	12	206 12	CKE
Lukiapang, *Da*	31 19 0 N	121 02	Sep 13, 11	10 8, 12 1	3 06 0 W			11 2, 11 7	33251	12		CKE
			Sep 14, 11	13 4, 14 7, 15 2	3 07 1 W			13 7, 14 3	33264	12		CKE
			Sep 14, 11	16 5, 16.8, 17 0	3 04 0 W			15 6, 16 1	33282	12		CKE
Lukiapang, *Db*	31 19 0 N	121 02	Sep 13, 11			14 7, 16 0	45 33 3 N				206 12(56)	CKE
			Sep 14, 11			8.7, 10.3	45 32 6 N				206 12(56)	CKE
Lukiapang, *F*	31 19 0 N	121 02	Sep 12, 11	14 2, 15.8	3 04 8 W			14 7, 15 5	33278	12		CKE
			Sep 12, 11	16 6, 17 8	3 02 8 W			16 9, 17 5	33277	12		CKE
			Sep 13, 11	8 4, 9 7	3 01.1 W			8 8, 9 4	.33244	12		CKE
Tatung	30 50.2 N	117 40	Aug 30, 11			17.1	44 58 6 N				206 12(56)	CKE
			Aug 31, 11	9 3, 10 6	2 19 2 W			9 7, 10 3	.33782	12		CKE
Anking	30 32 0 N	117 02	Aug 29, 11			12 0	44 27 4 N	15.1, 16 3	.34118	12	206.12(56)	CKE
Kiukiang	29 43 2 N	115 54	Aug 26, 11			17 8	43 26.7 N				206.12(56)	CKE
			Aug 28, 11	6 8, 9 2	1 45 2 W			7 3, 8 8	34387	12		CKE
Kuling	29 34 6 N	115 56	Aug 21, 11			17 8	43 19 4 N				206 12(56)	CKE
			Aug 22, 11	15.5, 17 1	1 45 0 W			16 0, 16 7	.34453	12		CKE
Wongkong	29 13 0 N	116 52	Aug 15, 11	8 5, 9.9	1 38 4 W	7.1	42 31 5 N	9 0, 9.6	34630	12	206 12(56)	CKE
Nanchang	28 41 7 N	115 51	Aug 12, 11	15 1, 16 7	1 36 6 W	17 9	41 52 2 N	16 2	34854	12	206 12(56)	CKE
Linkiang (Ho Quan)	28 03 3 N	115 25	Aug 10, 11	15 6, 17 2	1 25 0 W	10 9	40 47 1 N	16.1, 16 8	35166	12	206 12(56)	CKE
Kianfu	26 52 N	114 52	Aug 7, 11	9 4, 11 4	1 09 0 W	14.0	39 13 1 N	10 3, 11 1	35604	12	206 12(56)	CKE
Kanchow Ki	25 52 0 N	114 48	Aug 4, 11	9 3, 10 8	0 53 7 W	14 6	37 08 3 N	9 7, 10 5	36035	12	206 12(56)	CKE
Namyung	25 07 4 N	113 54	Jul 31, 11	8 2, 11 0	0 38 5 W	18 4	35 52 6 N	9 8, 10.7	36367	12	206.12(56)	CKE
Yunnanfu	25 04 6 N	102 45	Nov 18, 11	9 3, 10 8	0 21 8 E	13 4	35 12 8 N	9 7, 10 5	37190	12	206.12(56)	CKE
Kaokaitseu	24 47 8 N	103 09	Nov 14, 11			17 1	34 56.4 N				206 12	CKE
			Nov 15, 11	8 8, 10 3	0 16 7 E	11 1	34 56 1 N	9 3, 10.0	.37122	12	206 (56)	CKE
Shiuchow	24 47 6 N	113 22	Jul 26, 11	8.2, 10.2	0 34 8 W	17 0	35 17 2 N	9 0, 9 8	36514	12	206 12(56)	CKE
Posi	24 14.7 N	103 12	Nov 10, 11	14.6, 16.2	0 19 8 E	12 9	33 53 0 N	15.1, 15 9	37320	12	206 12(6)	CKE
Yingtak	24 10 0 N	113 18	Jul 24, 11	8.7, 10 5	0 29 0 W	17 8	34 06 7 N	9 3, 10 1	36828	12	206 12(6)	CKE
Mengtsz	23 28 3 N	103 25	Nov 8, 11	10 2, 11 7	0 23.7 E			11 4	.37501	12		CKE
			Nov 9, 11			11 7	32 32 8 N	10 4	37516	12	206 12(6)	CKE
Canton, *3*	23 06 1 N	113 19	Jul 15, 11			18.1	32 10 4 N				206 12(6)	CKE
			Jul 17, 11	8 6, 10 8	0 09 8 W			9 4, 10 5	37180	12		CKE
			Oct 3, 11	14 5, 15 9	0 13 0 W			14 9, 15 6	37196	12		CKE
			Oct 4, 11			17 2	32 09 2 N				206 12(6)	CKE
Hongkong Observatory, North Pier or *A*	22 19 2 N	114 10	Jul 2, 11					7 8, 11 8	37191	12		CKE
			Jul 2, 11					14 5, 17 5	37174	12		CKE
			Jul 5, 11					10 9, 15 3	.37180	12		CKE
			Jul 6, 11	10 6, 11 6, 12 7	0 01.0 W			6 4, 10 0	37170	12		CKE
			Jul 6, 11	13 5, 13 8, 14 7	0 01 5 W			15 3, 17 8	37171	12		CKE
			Jul 18, 11	10 5, 11 6	0 01 2 W			13 9, 16 8	37169	12		CKE
			Jul 19, 11	7 7, 8 9	0 01 7 E			10 4, 13 3	37145	12		CKE
			Jul 19, 11	15 0, 15 6, 16 5	0 00 8 W					12		CKE
			Jul 20, 11	11 3, 12 5	0 01 8 W					12		CKE
			Jul 20, 11	15 7, 16.7	0 01 4 W					12		CKE

[1]The values of inclination in Volume I for stations in China obtained with dip circle No 71, needles 7 and 8 or either one of them, should be corrected by applying +0 ′9. (See Table 3, Dip Corrections on Adopted C I W Standard, footnote 5, p 18)

[2]Omitted from table on p 68, Vol I, description, however, in that volume, p 137

ASIA.

CHINA—*Concluded.*

Station	Latitude	Long. East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Hongkong Observatory, South Pier or *A′*	22 19 2 N	114 10	Mar 3,'11	...	...	11.6, 13 1	30 56 1 N	...	...	...	206.12(56)	CKE
			Mar 4, 11	...	...	9 4, 10 2	30 56 8 N	...	...	...	206 12(56)	CKE
			Mar 4, 11	...	...	13 5, 14 6	30 56 9 N	...	...	...	206 12(56)	CKE
			Mar 6, 11	...	...	11 9, 13.1	30 56 2 N	...	...	...	206 12(56)	CKE
Hongkong Observatory, Tent or *B*.	22 19 2 N	114 10	Mar 1, 11	...	...	10 5, 14 5	30 58.2 N	...	...	...	206 12(56)	CKE
			Mar 2, 11	...	...	9.1, 12 0	30 58 2 N	...	...	...	206.12(56)	CKE
			Mar 2, 11	...	...	13 9, 16 3	30 58 1 N	...	...	...	206.12(56)	CKE
			Mar 5, 11	...	...	10 5, 14.3	30 57 0 N	...	...	...	206.12(56)	CKE
			Jun 29, 11	13.8, 14 2, 15 4	0 05 9 W	...	...	...	...	12	...	CKE
			Jun 29, 11	16.3, 17.1, 17 9	0 03 3 W	...	...	...	...	12	...	CKE
			Jun 30, 11	16.0, 16 8 ...	0 03 4 W	...	...	12 0, 13 6	37234	12	...	CKE
			Jul 1, 11	13 5, 14 3 ...	0 04 0 W	...	...	10 2, 11 2	.37237	12	...	CKE
			Jul 1, 11	...	...	...	...	16 7	.37184	12	...	CKE
			Jul 7, 11	9.1, 9 9, 15 1	0 01.7 W	...	...	10 7, 14 4	37194	12	...	CKE
			Jul 7, 11	15 8, 16.6, 17.2	0 02 6 W	...	...	...	...	12	...	CKE
			Jul 8, 11	...	...	...	...	8 7, 9 5	.37163	12	...	CKE
			Jul 8, 11	...	...	...	...	13 1, 13 9	.37198	12	...	CKE
			Jul 20, 11	17 3, 17 9 ...	0 04 0 W	...	...	...	...	12	...	CKE
			Jul 21, 11	6 7, 8 0 .	0 01.3 W	...	...	...	...	12	...	CKE
			Jul 21, 11	8 4, 8.9 . .	0 01 0 W	...	...	...	...	12	...	CKE
Chushan	21 32 0 N	107 58	Oct 17, 11	13 1, 14 4 .	0 17 0 E	11 9	28 52 5 N	13 5, 14 1	38070	12	206 12(6)	CKE
Pakhoi	21 30 0 N	109 06	Oct 12, 11	14.8, 16 4 ..	0 14 3 E		.	15 3, 16 0	37996	12	...	CKE
			Oct 13, 11	...	...	10 3 ..	28 49 0 N	...	.	.	206.12(6)	CKE
			Oct 14, 11	...	..	14 1 . ..	28 48 3 N	..	...	...	206 (6)	CKE

INDIA.

Station	Latitude	Long. East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Dehra Dun	30 19.3 N	78 03	Sep 30,'11	9 2, 10 6 ...	2 27 2 E	...	...	9.9, 15 1	.33274	14	...	LAB
			Sep 30, 11	14.2, 15 8	2 27 0 E	...	...	...	.	14	...	LAB
Karachi	24 49.4 N	67 02	Mar 9, 11	8.1, 10.2	1 41 4 E	14 5	34 36 0 N	8 7, 9.7	34520	7	202.1256	WHS
Alibag, *L*	18 38.3 N	72 52	Mar 22, 11	...	...	12.9, 13 8	23 44.9 N	...	...	..	202 12	WHS
			Mar 23, 11	8 6, 11.4	0 54 9 E	...	...	9 9, 11 0	.36832	7	...	WHS
			Mar 23, 11	13.0, 15.0 ...	0 53 8 E	...	...	13.5, 14 4	.36803	7	...	WHS
			Sep 19, 11	...	...	16 8	23 46.9 N	...	...	...	14 56	LAB
			Sep 20, 11	8 0, 9.8 . .	0 51.2 E	...	...	8 7 ..	36802	14	...	LAB
			Sep 21, 11	7.6, 8.8 .	0 53 7 E	...	...	8 2 ...	36810	14	...	LAB
Alibag, *U*.	18 38 3 N	72 52	Mar 23, 11	15 9, 17 8	0 56 8 E	...	...	16 4, 17 4	36794	7	...	WHS
			Mar 24, 11	7.5, 9 3	0 57 7 E	...	...	8 0, 8 8	36799	7	...	WHS
			Sep 19, 11	14 2, 15 6 ...	0 53 3 E	...	...	14 9 .	.36848	14	...	LAB
			Sep 21, 11	9 2, 10 1 .	0 54 2 E	...	...	9 6 . ..	.36834	14	...	LAB
Alibag, *Us*	18 38.3 N	72 52	Mar 22, 11	...	.	16 0, 16 8	23 45 4 N	...		...	202 12	WHS
			Sep 20, 11	...	.	10 8 ..	23 46 1 N	.. .	.	...	14 56	LAB

INDO-CHINA.

Station	Latitude	Long. East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Laokai	22 28 0 N	104 00	Nov 6,'11	8 1, 9 7	0 27 1 E	11 3 .	30 29 8 N	8 7, 9 4	37993	12	206 12(56)	CKE
Langson	21 51 6 N	106 42	Oct 30, 11	9 8, 11 2	0 19 8 E	15 5 .	29 25 4 N	10 2, 10 9	38046	12	206 12(6)	CKE
Yenbay.	21 38 5 N	104 54	Nov 4, 11	15 3, 16.9 ..	0 27 6 E	...	.	15 8, 16 6	38136	12	.	CKE
			Nov 29, 11	...	.	14 8 .	29 04 1 N				206 12(6)	CKE
Hanoi	21 03 2 N	105 50	Nov 3, 11	9.7, 11 5 ..	0 21 0 E	16 7 . .	27 49 0 N	10 3, 11 1	38313	12	206 12(56)	CKE
Phu Lien	20 48 4 N	106 38	Oct 21, 11	8 7, 10 4 .	0 20 8 E	15 0	27 22 6 N	9 3, 10.1	38324	12	206.12(56)	CKE
			Dec 6, 11	15 0	0 18.4 E	16 8	27 22 0 N	15 6	38373	12	206 12(56)	CKE
Vinh	18 40.7 N	105 36	Oct 27, 11	10 3, 11.7 . .	0 32 0 E	14 2 . .	22 50 7 N	10 6, 11 3	39004	12	206 12(56)	CKE
Paksane	18 22.5 N	103 34	Jan 7, 12	...	...	12 2 ..	21 59 6 N				206 12	CKE
Vientiane	17 57.8 N	102 30	Jan 9, 12	...	...	16 2 .	21 10 5 N				206 12(56)	E&K
			Jan 10, 12	8 8, 10 3 ..	0 30 0 E	15 4 .	21 11 5 N	9 2, 9 9	.39212	12	206 (56)	E&K
Pakhinboun	17 35 2 N	104 31	Jan 5, 12	16 4	0 30 3 E	14.2 ..	20 22 3 N	16 9, 17 6	39110	12	206 12(56)	E&K
			Jan 6, 12	7 0	0 28 3 E	...	..	.		12	...	E&K
Quangtri	16 45 1 N	106 51	Dec 18, 11	8 2	0 41 1 E	15 3	18 53 0 N	8 7 .	39218	12	206 12(56)	CKE
Tchépone	16 41 3 N	106 03	Dec 23, 11	13 5, 15 0 ..	0 39 8 E	10 7 .	18 33 2 N	14 0, 14 6	39230	12	206.12(56)	CKE

ASIA.

INDO-CHINA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Laobao	16 35 N	106 24	Dec 21,'11	17 6	0 42 3 E	17 2	18 29 4 N			12	206 12	CKE
			Dec 22, 11	6 2	0 40 6 E			6 6	.39233	12		CKE
Savannakhet	16 32 7 N	104 40	Jan 2, 12	15 0, 16 4	0 39 3 E	11 2	18 13 2 N	15.5, 16 1	.39347	12	206 12	E&K
			Jan 3, 12			12 8	18 12 5 N				206 12(56)	E&K
			Jan 13, 12			16 5	18 13 8 N				206 12(56)	E&K
			Jan 14, 12	9 2, 10 5	0 38 6 E			9.6, 10.2	.39391	12		E&K
Hué	16 26 N	107 12	Dec 12, 11			17.4	18 15 2 N				206 12(5)	CKE
			Dec 13, 11	9 0, 10 7	0 40 6 E			9 4, 10 3	39240	12		CKE
Bantacheng	16 22 5 N	105 34	Dec 27, 11			16 9	17 54.8 N				206 12	CKE
			Dec 28, 11	8 4, 10 0	0 41.0 E			8 9, 9 7	39293	12		CKE
Donsa	16 06 N	105 01	Jan 16, 12	8 8, 10 2	0 41 4 E	12 2	17 14 3 N	9.2, 9 8	.39476	12	206 12(56)	E&K
Tourane	16 04 3 N	107 53	Dec 11, 11			9 9	17 28 7 N	12 1	.39240	12	206 12(56)	CKE
			Dec 14, 11	14 2, 15 8	0 43 0 E			14.7, 15.6	.39198	12		CKE
Paksé, *A*	15 10 N	105 43	Jan 17, 12	17 5	0 38 4 E	17 6	14 59 3 N	17.8	39509	12	206 1	E&K
Paksé, *B*	15 10 N	105 43	Jan 18, 12	8 2, 10 5	0 38 4 E	11.8	14 57 8 N	8.8, 10 1	39515	12	206 12(56)	E&K
Bassac, *A*	14 53 N	105 50	Jan 18, 12	17 0	0 44 2 E					12		CKE
Bassac, *B*	14 53 N	105 50	Jan 18, 12			17.0	14 39 7 N				206.12	NYK
Stungtreng	13 32 N	105 56	Jan 20, 12			17 8	11 17 2 N				206 12	CKE
Angkor-Vat	13 25 5 N	103 52	Jan 29, 12	9 2, 10 7	0 39 0 E	17 1	10 40 1 N	9 7, 10 4	39807	12	206.12(56)	E&K
Kratié, *A*	12 29 0 N	106 02	Jan 22, 12	16 2, 17 6	0 53 2 E	13 6	9 07 8 N	16 6, 17 3	39788	12	206 12(56)	E&K
Kratié, *B*	12 29 2 N	106 02	Jan 23, 12	8 4, 10 4	0 55.2 E	13 6	9 09 0 N	9 2, 10.1	39813	12	206 12(56)	E&K
Pnompenh	11 34 N	104 57	Jan 25, 12	15 0, 16 7	0 52 1 E			15 5, 16.3	.39904	12		E&K
			Feb 2, 12			8 8	6 51 0 N				206 12(56)	E&K
Phantiet	10 57.5 N	108 05	Feb 8, 12	16 3, 18 0	1 07 2 E			16 7, 17.6	39777	12		CKE
Phantiet, Secondary	10 57.5 N	108 05	Feb 8, 12			17.3	5 35 8 N				206 12(56)	NYK
Saigon	10 48 N	106 47	Feb 6, 12	9 1, 11 2	1 00.1 E	13 0	5 05 2 N	9 7, 10 7	.39826	12	206 12(56)	E&K
Hongchong	10 09.1 N	104 38	Feb 11, 12	13 7, 14 8	0 52.6 E			14 0	39882	12		CKE
Hongchong, Secondary	10 09.1 N	104 38	Feb 11, 12			14.4	3 31.3 N				206 12(56)	NYK

SIAM.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Mehphuak	17 56 2 N	100 06	Feb 17,'12	15.3, 17 3	0 25 8 E			16 2, 17 0	39210	12		E&K
			Feb 18, 12			9.7	20 57 2 N				206 12(56)	E&K
Pitsanuloke	16 49 1 N	100 16	Feb 16, 12	9 0, 10 6	0 25.1 E	16 9	18 34 4 N	9.4, 10.2	39324	12	206 12(56)	E&K
Paknampoh	15 42 5 N	100 11	Feb 27, 12	15 8, 17 4	0 26.6 E			16 2	39605	12		CKE
Paknampoh, Secondary	15 42 5 N	100 11	Feb 27, 12			16 4	15 59 3 N				206.12(56)	NYK
Korat	14 58 0 N	102 08	Feb 21, 12	8 6, 10 0	0 25 8 E	11 3	14 33 1 N	9 0, 9 6	39568	12	206 12(56)	E&K
Lopburi, *A*	14 47 6 N	100 39	Feb 19, 12	15 1	0 40 3 E	17.9	14 07 2 N	15 5	39777	12	206 (56)	E&K
			Feb 20, 12	9 5	0 40 4 E	7 2	14 06 8 N	9 2	.39756	12	206 12	E&K
			Feb 28, 12	12 0	0 41 5 E					12		E&K
Lopburi, *B*	14 47 6 N	100 39	Feb 28, 12	16 4, 17 8	0 42 0 E	14 4	14 07 2 N	16 7, 17 5	39744	12	206 12(56)	E&K
Ayuthia	14 23 0 N	100 37	Feb 29, 12	10 7, 11 4	0 30 7 E	12 3	12 52 8 N	11 0	39796	12	206 12	E&K
Bangkok	13 44.1 N	100 32	Feb 14, 12	8 6, 10 1	0 28.0 E	12 2	11 29 7 N	9 1, 9 8	39860	12	206 12(56)	E&K
Huahin	12 34 3 N	100 03	Feb 24, 12	8 7, 10 1	0 23 6 E	15 5	8 49 1 N	9.2, 9.8	39898	12	206.12(56)	E&K

TURKISH EMPIRE.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Anah	34 29 4 N	42 00	Jan 8,'11	10 2, 11 7	0 58 6 E	14.2	47 37.0 N	10 6, 11 4	28578	7	202.1256	WHS
Hillah	32 29 0 N	44 33	Jan 26, 11	9 5, 11 8	1 13 4 E	14.6	45 02 4 N	10 3, 11.4	.29668	7	202 1256	WHS
			Jan 27, 11	13 8, 15 0	1 13.4 E			14.3	.29657	7		WHS
Amara	31 50 8 N	47 12	Feb 10, 11	10 0, 11 6	1 48.8 E	14 2	44 10 2 N	10 5, 11 2	30200	7	202 12	WHS
Basra	30 32 6 N	47 50	Feb 13, 11	10 2, 11.7	1 43 4 E	14.9	42 10 5 N	10 6, 11 4	30827	7	202.1256	WHS
			Feb 15, 11			11 5	42 12 2 N				202 56	WHS
Muscat	23 38 3 N	58 35	Feb 27, 11	9 4, 11 5	1 33 6 E	14 8	32 01 8 N	10 0, 10 9	34555	7	202 1256	WHS
Jidda	21 28 3 N	39 11	May 4, 11			15 9	25 28 0 N				202 12	WHS
			May 5, 11	8 3, 10 9	1 17.1 W			8 9, 9 8	33733	7		WHS
Hodeida	14 47 6 N	42 56	Apr 21, 11	8 8, 10 7	0 58 6 W	14.2	11 02 4 N	9.4, 10 3	35174	7	202 1256	WHS
Aden	12 47 2 N	44 59	Apr 1, 11	10 1, 12 1	0 53 0 W	15.4	7 05 9 N	10 7, 11 7	35540	7	202 1256	WHS

AUSTRALASIA.

AUSTRALIA.

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Thursday Island, *B*	10 34 5 S	142 13	Oct 21,'12	11 2, 11 4	4 58 7 E					*172*		FWC
			Oct 21, 12	11 6, 11 9	4 59 2 E					*172*		FWC
Thursday Island, *C*	10 34 5 S	142 13	Oct 21, 12	12.4, 12 6	4 59.2 E					*172*		FWC
			Oct 21, 12	12 8, 13 0	4 59.5 E					*172*		FWC
Thursday Island, *A*	10 34 9 S	142 12	Oct 10, 12	10 3, 11 6, 20 4	4 54 6 E	14 8	33 18 8 S	10 7, 11 3	36892	17	172 15	K&C
			Oct 10, 12	20 5 to								
			Oct 11, 12	1.5(dv)	4 57 3 E					17		K&C
			Oct 11, 12	1.6	4 57.1 E					17		K&C
			Nov 7, 13	11.7, 14 4	4 56 4 E	15 6	33 25 7 S	12 2, 13 2	.36863	17	172 125	FB
Albany Island	10 43 9 S	142 36	Oct 18, 12	13 3, 14 7	5 05 2 E	16 0	33 28 2 S	13 7, 14 4	.36762	17	172.12	EK
Mapoon Mission	11 57.8 S	141 53	Nov 15, 13	9 0, 11 1, 16 0	4 58 9 E	14 6	35 48 9 S	9 7, 10.7	.36528	17	172.125	FB
			Nov 22, 13	9 8	4 57 8 E					17		FB
			Nov 22, 13	10 1 to								
			Nov 23, 13	9 6(dv)	5 00 0 E					17		FB
			Nov 23, 13	9 8	4 56 8 E					17		FB
Connell's Creek	12 17 4 S	131 33	Sep 23, 12	9 1, 10 8	3 25 6 E	14 0	37 46 9 S	9 6, 10 4	.36210	17	172 125	EK
Port Darwin	12 26 7 S	130 50	Sep 27, 12	10 0, 11 8	3 23 4 E	14 4	38 10 5 S	10 4, 11 5	36229	17	172.25	K&C
			Sep 30, 12	14 0	3 28 8 E					17		K&C
			Sep 30, 12	14 6 to								
			Oct 1, 12	14 6(dv)	3 24 6 E					17		K&C
			Oct 1, 12	14 8	3 28 2 E					17		K&C
Weipa Mission	12 44 6 S	142 10	Dec 1, 13	9 5, 11 2	5 03 6 E	14 7	37 08 6 S	10 0, 10.9	36328	17	172 125	FB
Batchelor	13 03 6 S	131 03	Sep 14, 12	9 5, 10 8	3 29 5 E	13 3	39 06 0 S	10 0, 10 5	35910	17	172 25	K&C
Mien	13 12 8 S	142 49	Dec 8, 13	8.4, 10 4	5 13 0 E	14 2	37 47 2 S	9 0, 10 0	.36216	17	172 125	FB
Pine Creek	13 49.6 S	131 51	Sep 11, 12	9 2, 10.7	3 28 2 E	13 7	40 19.4 S	9 6, 10 4	35655	17	172 125	EK
Coen	13 57.2 S	143 12	Dec 12, 13	9 7, 11 4	5 22 6 E	6 9	38 57 6 S	10 2, 11.0	36005	17	172 125	FB
Katherine River	14 26 1 S	132 17	Sep 4, 12	9 3, 10.5	3 38 4 E	14.3	41 14.3 S	9.6, 10 2	35585	17	172.125	EK
Leech's Billabong	14 44.1 S	132 52	Aug 31, 12	13 0	3 42 7 E	14.6	41 29.7 S	13 4	35464	17	172 12	EK
Musgrave	14 47.4 S	143 31	Dec 17, 13	9.6, 16.6	5 26 2 E	14 4	40 14 6 S	10 3, 11 2	37748	17	172 125	FB
Elsey Creek	15 06 2 S	133 08	Aug 26, 12	13.4, 15.0	3 41.9 E	16 6	42 00 9 S	13 9, 14 7	35356	17	172.125	EK
Cooktown	15 28 6 S	145 17	Nov 26, 12	9 9, 11.4	5 49 4 E	12 4	41 00 2 S	10 4, 11 1	.35539	17	172.125	K&C
			Dec 23, 13	14.5, 16 4	5 51 6 E	12.2	41 05.3 S	15 0, 15 9	.35484	17	172 12	FB
Laura	15 33.2 S	144 30	Nov 21, 12	9 2, 11 0	5 40 8 E	13 8	41 19 8 S	9 7, 10 5	.35480	17	172 125	K&C
			Nov 22, 12	11.6, 14 8	5 44 6 E			15 7	35463	17		K&C
			Nov 22, 12					21 6, 22 5	.35406	17		K&C
			Nov 22, 12					18 9 to				
			Nov 23, 12					18 9(dv)	35513	17		K&C
			Nov 23, 12					6 1, 7 0	.35446	17		K&C
			Nov 23, 12					15 6, 16 5	.35424	17		K&C
Laura, Secondary	15 33.2 S	144 30	Nov 22, 12	17.7, 17.9	5 42.4 E					*172*		FWC
No 3 Well	15 38 0 S	133 13	Aug 23, 12	10 4	3 46 0 E	13 9	42 46 4 S	10 8	35188	17	172.12	EK
Daly Waters	16 19 8 S	133 25	Aug 14, 12	16 1, 17 4	3 53 4 E			16 5, 17 1	35032	17		EK
			Aug 15, 12			9 2	43 56 0 S				172 125	EK
Milner's Well	16 41 5 S	133 26	Aug 13, 12	9.7	3 56 7 E	10 9	44 39 4 S	10 1	34795	17	172 12	EK
Cairns	16 55 6 S	145 46	Nov 18, 12	9 7, 11.3	5 59 6 E	12 6	43 04 8 S	10 2, 10 9	.35206	17	172 125	EK
Frew's Ponds	16 58 8 S	133 27	Aug 11, 12	17.0	4 05 6 E			17 4	34609	17		EK
			Aug 12, 12			8 3	45 10 6 S				172 12	EK
Chillagoe	17 10 0 S	144 34	Nov 14, 12	10 1, 11 3	5 47 0 E	14 5	43 47 6 S	10 5, 11 1	34918	17	172 125	EK
Newcastle Waters	17 23 0 S	133 26	Aug 9, 12	8 8, 10 2	3 48 0 E	13 8	45 47 3 S	9 3, 9 9	34214	17	172.1256	EK
Newcastle Waters, Secondary	17 23 0 S	133 26	Aug 9, 12	16 3, 16 6	3 46 9 E					*172*		EK
Normanton	17 41 4 S	141 06	Nov 4, 12	10 5, 12.1	5 25 8 E	14 3	45 01 1 S	11 0, 11 7	.34558	17	172 156	EK
Burketown	17 45 1 S	139 28	Oct 28, 12	10 6, 11.8	5 12 8 E	14 2	45 20 4 S	10 9, 11 5	34707	17	172 156	K&C
			Nov 1, 12			11 1	45 19 5 S				172 156	K&C
Anthony Lagoon	17 58 9 S	135 31	Oct 4, 13	13.2, 15 4	4 23 6 E	10 6	46 17 6 S	13 8, 14 8	34193	17	172 1256	FB
Powell's Creek	18 04 8 S	133 41	Aug 3, 12	9 6, 11 8	3 54.8 E	14 6	46 29 9 S	10 2, 11 2	34108	17	172.1256	EK
Powell's Creek, Secondary	18 04 8 S	133 41	Aug 5, 12	11 5, 11 9	3 42.4 E					*172*		EK
Croydon	18 13.1 S	142 15	Nov 6, 12	14 2, 16.1	5 35.4 E	12 1	45 35 3 S	14 7, 15 6	.34464	17	172 1256	K&C
Croydon, Secondary	18 13 1 S	142 15	Nov 7, 12	17 3, 17.6	5 31.5 E					*172*		FWC
Cardwell	18 15 8 S	146 02	Dec 3, 12			16 2	45 19 6 S				172 1256	FWC
			Dec 4, 12	10 8, 14 4	6 10 3 E			11 5, 13 4	34332	17		FWC
Renner Spring	18 19.2 S	133 48	Aug 1, 12	14.1, 15.5	4 00 8 E	16 7	46 54 2 S	14 6, 15 2	34021	17	172 1256	EK
Forsayth	18 35 1 S	143 38	Nov 11, 12	10.6, 12 1	5 43 9 E	15 4	45 59 8 S	11 1, 11 8	34270	17	172 1256	K&C
Mooketa Rock Hole	18 38 0 S	133 54	Jul 30, 12			17.4	47 20 1 S				172.125	EK
			Jul 31, 12	8 4, 9 8	3 58 5 E			9 3, 9 5	33946	17		EK
Brunette Downs	18 38 7 S	133 55	Oct 6, 13			14 5	47 08 6 S				172 1256	FB
			Oct 7, 13	8.8, 11 1, 11 4	4 08 0 E			9 3, 10 5	34028	17		FB
Attack Creek	19 00 9 S	134 10	Jul 28, 12	17 5	4 07.6 E			17 9	33785	17		EK
			Jul 29, 12			8 0	47 43 0 S				172 12	EK

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	γ			
Alexandria	19 04 0 S	136 39	Oct 2,'13	9 1, 11 2	4 18 0 E	13 7	47 28 0 S	9.6, 10 6	33870	17	172 12	FB
			Oct 2, 13					15 4	33836	17		FB
Townsville	19 14 6 S	146 50	Nov 29, 12			17 3	46 31 3 S				172 1256	FWC
			Nov 30, 12	11 1, 14 8	6 35.4 E			12 3, 14.3	34142	17		FWC
			Nov 24, 13	13 8, 14 8	6 39 6 E	15 7	46 35 4 S	14.2	34059	6	41 (78)	EK
Canobie	19 28 3 S	140 57	Nov 20, 13	11 6, 13 0	5 58 0 E	14 8	47 28 8 S	12 0, 12 6	33686	6	41 (78)	EK
Tennants Creek	19 33 4 S	134 15	Jul 26, 12	9 8, 11 4	4 00 0 E	13 8	48 25 6 S	10 3, 11 0	33475	17	172 1256	EK
Mount Samuel	19 43 0 S	134 11	Jul 24, 12			17 2	49 40 2 S				172 12	EK
			Jul 25, 12	8 5	3 48.8 E			9 6	33286	17		EK
Camooweal	19 55 6 S	138 06	Sep 30, 13	14 2, 16 6	4 27 0 E	10 8	48 39 6 S	15 1, 16 1	33608	17	172.156	FB
			Oct 1, 13	6 7	4 24 4 E			7 8	.33655	17		FB
Bowen	20 00 8 S	148 15	Nov 10, 13	14 8, 16 2	6 44 0 E	12 4	47 32 8 S	15.2, 15 9	.34111	6	41 (7)	EK
			Nov 11, 13			9 3	47 36 9 S				41 (78)	EK
Charters Towers	20 04 4 S	146 15	Nov 13, 13	13 9, 15 7	6 31 4 E	11 3	47 29 9 S	14 4, 15 3	.33887	6	41.(78)	EK
Gilbert Creek	20 11 8 S	134 14	Jul 22, 12			17 2	49 25 8 S				172 1256	EK
			Jul 23, 12	8 8, 10 0	3 54 8 E			9 2, 9.8	33212	17		EK
Wycliffe Well	20 41 4 S	134 15	Jul 20, 12	16 3	3 57 5 E	17 7	50 07 9 S	16 9	.33009	17	172 12	EK
Cloncurry.	20 42 4 S	140 30	Oct 13, 13	14 5, 16 5	4 50 6 E	11 0	49 32.5 S	15.1, 16 1	33626	17	172 1256	FB
Richmond	20 45 2 S	143 09	Nov 17, 13	14 3, 15 8	5 45 5 E	12 0	49 03 8 S	14.7, 15 5	33396	6	41.(78)	EK
Hughenden	20 50 4 S	144 12	Nov 15, 13	10 8, 12 4	6 05 4 E	14.4	49 06 2 S	11 3, 12 0	33282	6	41.(78)	EK
Mackay	21 08 8 S	149 11	Nov 7, 13	11 2, 12 7	7 13 2 E	15 1	48 54 9 S	11 6, 12 4	33237	6	41 (78)	EK
Taylor's Crossing	21 14 8 S	134 08	Jul 18, 12	13 3, 15 0	3 32 6 E	16 3	50 59 1 S	14 0, 14 6	32446	17	172.1256	EK
Barrow Creek	21 32 0 S	133 53	Jul 15, 12	9 3, 10.9	3 33 4 E	13 9	51 21 1 S	9 8, 10 6	32506	17	172.1256	EK
Mount Douglas	21 32 2 S	146 51	Oct 30, 13	8 6, 10 8	6 50 2 E	12 5	49 32 0 S	9.4, 10 4	33110	6	41 (78)	EK
Kynuna	21 34 6 S	141 56	Oct 15, 13	9 0, 11 3	5 46 8 E	14 6	50 33 5 S	9 6, 10 7	32786	17	172.1256	FB
Urandangi	21 36 9 S	138 20	Sep 27, 13	14 3, 16 5	4 48 6 E			14 9, 15.9	32642	17		FB
			Sep 28, 13	9 5, 11 4	4 44 7 E	14 0	50 49 2 S	10 1, 11 0	.32636	17	172 1256	FB
Hanson's Well	21 47 8 S	133 39	Jul 10, 12			16 8	51 46 6 S				172 12	K&C
			Jul 11, 12	9 1	3 38 6 E			10 0	32294	17		K&C
Teatree Well	22 08 3 S	133 23	Jul 9, 12	9 0, 10 4	3 39 7 E	11 2	52 10 8 S	9 5, 10 0	.32012	17	172.1256	K&C
St Lawrence	22 20 8 S	149 32	Nov 4, 13	9 6, 11 3	7 31 1 E	7 6	50 33 6 S	10 1, 10 9	32704	6	41.(78)	EK
Winton	22 24 1 S	143 03	Oct 17, 13	14 5, 16 7	6 09 2 E	10 7	51 23.5 S	15 1, 16.0	.32288	17	172.1256	FB
			Oct 18, 13	7 4	6 04.7 E			8.0	.32197	17		FB
Eastmere	22 29 7 S	145 53	Oct 22, 13	13 1, 15 2	6 37 4 E	11.1	51 22 3 S	14 1, 14.8	32435	6	41.(78)	EK
Ryan's Well	22 43 4 S	133 21	Jul 6, 12	14 6	4 03 3 E	16 2	53 03 2 S	15.0	.32000	17	172 1256	EK
Clermont	22 49 2 S	147 38	Oct 25, 13	10 8, 12 2	7 04 2 E	14 6	51 02 8 S	11 2, 11 9	32532	6	41.(78)	EK
Boulia	22 54 7 S	139 56	Sep 24, 13	14 0, 16 2	5 38 0 E	10 4	52 19 6 S	14 6, 15 6	31987	17	172.1256	FB
Burt Well	23 13 0 S	133 45	Jul 4, 12	8 6, 10 0	3 43 6 E	11 1	53 30.8 S	9 0, 9.6	.31406	17	172 1256	EK
Winnecke's	23 19 7 S	134 15	Jul 1, 12			17 3	53 12.4 S				172.12	EK
			Jul 2, 12	8 3	4 12 3 E			8 7	31974	17		EK
Rockhampton	23 22 0 S	150 30	Sep 6, 13			15 8	51 12 5 S				172 1256	FB
			Sep 8, 13	8 9, 11 4	8 00 6 E			9.6, 10 8	32542	17		FB
Arltunga	23 26 2 S	134 41	Jun 29, 12	8 8, 10 2	3 47.7 E	11 4	53 35 8 S	9 3, 9 9	31728	17	172.1256	K&C
Arltunga, Secondary	23 26 2 S	134 41	Jun 29, 12	15 2, 15 6	3 45 0 E					172		K&C
Longreach	23 26 4 S	144 15	Sep 11, 13	14.2, 15 4	6 22 6 E	11 0	52 33.6 S	14 6, 15 1	.31903	17	172.1256	K&B
Emerald	23 30 8 S	148 10	Sep 9, 13	14 3	7 18 9 E	11 6	52 26 0 S	15 1	.31874	17	172.12	FB
Vergemont	23 31 5 S	143 02	Sep 17, 13	9 0, 11 6	6 03 6 E	17 1	52 56 4 S	9 5, 10 9	.31770	17	172 12	FB
			Sep 17, 13	13 3, 15 4	6 08.0 E			13 9, 14 8	31775	17		FB
Mayne Junction Hotel	23 32 1 S	141 23	Sep 19, 13	9 5, 12.5	5 54 6 E	15 0	53 21 9 S	10.2, 11.4	31431	17	172.1256	FB
Jericho	23 35 7 S	146 08	Oct 15, 13			14 9	52 45.3 S				41.(78)	EK
			Oct 16, 13	9 9, 11.4	6 39.8 E			10.3, 11 1	31780	6		EK
Alice Springs	23 40 8 S	133 54	Jun 22, 12	10 0, 11.7	3 45 0 E	14 8	54 05 0 S	10 6, 11.4	31286	17	172 1256	EK
Alice Springs, Secondary	23 40 8 S	133 54	Jun 22, 12	17 3	3 41 8 E					172		EK
Gladstone	23 51.0 S	151 15	Oct 4, 13	15 0, 16 6	8 08.0 E			15 4, 16 2	31982	6		EK
			Oct 6, 13			11 6	52 05 7 S				41 (78)	EK
Temple Bar	23 56 4 S	133 57	Jun 19, 12			17 1	54 30 2 S				172 12	EK
			Jun 20, 12	8 3	3 50 7 E			8.7	.31107	17		EK
Ooraminna Well	24 21 2 S	134 04	Jun 18, 12	8 9, 10 5	3 55.4 E	11 3	54 55 8 S	9 5, 10 2	30939	17	172 1256	EK
Stonehenge	24 21 2 S	143 18	Sep 13, 13	9 7, 11 1	6 05 8 E	13 9	53 53 4 S	10 2, 10 8	31382	17	172 1256	K&B
Bedourie	24 21 6 S	139 29	Sep 22, 13	9 0	5 24 0 E	14 7	54 37 1 S	9 6	30864	17	172 1256	FB
Rolleston	24 27 8 S	148 37	Oct 13, 13	14 9, 16 8	7 13 2 E	10 3	53 50 8 S	15 5, 16 5	.31196	6	41 (78)	EK
Malvern Bore	24 30 8 S	144 59	Oct 17, 13	14 7	6 41 0 E	13 8	53 51 2 S	15 1	31427	6	41.(78)	EK
Alice Well	24 47 4 S	134 09	Jun 15, 12			16.7	55 39 8 S				172 12	EK
			Jun 16, 12	8 3	4 01 9 E			8 7	.30504	17		EK
Tambo	24 53 3 S	146 16	Aug 8, 13			17.4	54 02 4 S				172 12	EK
			Aug 9, 13	10 3, 11 5	6 53 7 E			10 6, 11 2	31305	17		EK

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M. T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Currawilla	25 08 4 S	141 20	Aug 16,'13	9.0, 12 1	5 41 8 E	13 5	55 04 9 S	9.8, 10 7	30848	17	172.125	K&B
Horseshoe Bend	25 11.1 S	134 15	Jun 13, 12	15 4, 16 7	3 43 6 E			15 8, 16 3	30384	17		EK
			Jun 14, 12			9 1	56 00 8 S				172 1256	EK
Windorah	25 25 4 S	142 39	Aug 14, 13	9 8, 11.5	6 07 7 E	14 6	55 14 8 S	10 3, 11 0	30764	17	172 12	K&B
Crown Point	25 30 2 S	134 24	Jun 12, 12	8 4, 9 7	4 02 4 E	10 6	56 15 9 S	8 8, 9 4	30238	17	172 156	EK
Maryborough	25 32 0 S	152 42	Sep 3, 13			11 0	54 01 7 S				172 1256	FB
			Sep 4, 13	9 5, 12 0	8 35 8 E			10 1, 11 2	.31210	17		FB
Gayndah	25 37 7 S	151 37	Oct 8, 13	14 2, 15 8	8 12 0 E	11 6	54 04 8 S	14.7, 15 5	31050	6	41 (78)	EK
Goyder Creek	25 38 4 S	134 39	Jun 10, 12	15 8	3 49 2 E	14 7	56 35.8 S	16 2	30087	17	172 12	EK
Taroom	25 38 8 S	149 48	Sep 30, 13	10 4, 12 3	7 51 7 E	15 0	54 27.8 S	11.0, 11 9	31024	6	41 (78)	EK
Adavale	25 54 8 S	144 35	Aug 12, 13	10 1, 11 5	6 29 2 E	14 1	55 36 8 S	10 4, 11.1	.30533	17	172 12	K&B
Charlotte Waters	25 55 9 S	134 55	Jun 7, 12			17 1	56 57 5 S				172 1256	EK
			Jun 8, 12	9.0, 11 1	3 57 0 E			9 5, 10 3	.29916	17		EK
Blood's Creek	26 18 8 S	135 06	Jun 5, 12	9 4, 11 0	4 23 8 E	14 2	57 23.6 S	9 8, 10 4	.29500	17	172 1256	EK
Charleville	26 24 4 S	146 14	Aug 7, 13	10.4, 11 6	7 03 8 E	14 8	56 01 0 S	10.7, 11 3	.30459	17	172 125	K&B
Roma	26 34.0 S	148 48	Aug 5, 13	11 2, 12.4	7 40 2 E	14 8	55 40.7 S	11 5, 12 1	30541	17	172.125	K&B
Meekatharra	26 35 2 S	118 30	Apr 20, 12			16 4	59 01.9 S				172.1256	EK
			Apr 21, 12	10 8, 12 2	1 05.5 W			11.1, 11 8	.28162	17		EK
Meekatharra, Secondary	26 35 2 S	118 30	Apr 22, 12	9.5	1 00 9 W					*172*		EK
Eromanga	26 40 1 S	143 16	Aug 19, 13	13 4, 15 1	6 24 6 E	10 8	56 40.2 S	13 8, 14 5	30013	17	172.1256	K&B
Woodgate's Swamp	26 40 6 S	135 29	Jun 2, 12			16.8	57 32 4 S				172 1256	EK
			Jun 3, 12	7 2, 8 8	4 06.0 E			7 8, 8 5	29678	17		EK
Chinchilla	26 44 6 S	150 38	Aug 2, 13	14 0, 15.7	8 19 4 E	11.1	55 45.1 S	14 3, 15 1	30412	17	172 125	EK
Box Tree Flat	27 10 4 S	135 30	May 31, 12	9.0, 10 9	4 29 5 E	14 4	58 14 2 S	9 5, 10 2	29299	17	172.1256	EK
Brisbane	27 27.0 S	153 02	Jul 17, 13	10 8, 12 3	9 03 3 E	15.3	56 09 9 S	11 3, 12.0	30154	17	172 125	EK
Brisbane University	27 28 7 S	153 02	Nov 29, 13	14 5	9 14.3 E			12.3	.30135	6		EK
			Nov 29, 13	16.6 to								
			Nov 30, 13	16 6(dv)	9 12.5 E					6		EK
			Nov 30, 13	16 8	9 12 4 E					6		EK
			Dec 1, 13			10 4	56 15 1 S				41 (7)	EK
Toowoomba	27 32.8 S	151 57	Jul 23, 13	14 4, 15 7	8 30 4 E	17.1	56 20.4 S	14 9, 15.4	.30120	17	172.12	EK
Oodnadatta	27 33.1 S	135 28	Aug 21, 11	10 0, 11.7	4 10 4 E	11 1, 13 7	58 26 5 S	10.4, 11 2	.29177	9	41.56	K&W
			May 26, 12	10 1, 11.7	4 11 2 E	14 4	58 32 5 S	10 6, 11 3	29190	17	172 1256	EK
Southport	27 58 7 S	153 26	Jul 19, 13	10.3, 11.8	9 02 8 E	14.2	56 39.2 S	10 7, 11.4	.29868	17	172 1256	EK
Sandstone	27 59.0 S	119 15	Apr 27, 12	14 3, 15.8	1 02 8 W	17 0	60 27.0 S	14 7, 15 4	.27261	17	172 12	EK
Thargomindah	27 59 7 S	143 49	Aug 21, 13	9 7, 11 9	6 38 0 E	14.0	58 10.5 S	10 1, 11 2	29319	17	172 1256	K&B
Mount Magnet, *B**	28 02.3 S	117 49	Apr 24, 12	11 6	44 24.3 E	11.9	64 16.2 S			*172*	172.1	EK
			Apr 25, 12	11 0	52 15 1 E			11 0[1]	.28834	17		EK
Mount Magnet, *C**	28 02.3 S	117 49	Apr 24, 12	14.0	21 29 2 E	14 3	72 10 5 S			*172*	172 1	EK
Mount Magnet, *D**	28 02.4 S	117 49	Apr 24, 12	15.3	9 41.9 E	15 4	64 32.3 S			*172*	172 1	EK
Mount Magnet, *E**	28 02.5 S	117 49	Apr 24, 12	16 0	13 14.7 E	16 2	63 40.0 S			*172*	172 1	EK
			Apr 25, 12	15 4	13 11 2 E			15.4[1]	.23764	17		EK
Mount Magnet, *F**	28 02 5 S	117 49	Apr 25, 12	16 2	4 28 0 E					*172*		EK
Mount Magnet, *A**	28 04.3 S	117 51	Apr 23, 12	14 2, 15 8	1 28 0 W	12.1	60 44 6 S	14 7, 15 4	27078	17	172.1256	EK
Cunnamulla	28 04.3 S	145 42	Aug 23, 13	10 4, 12 6	6 57.1 E	14 5	58 02 5 S	10 8, 11.8	.29365	17	172.1256	K&B
Lawlers	28 05 2 S	120 30	May 1, 12	11 2, 12 8	0 22 6 W	15 0	61 06 6 S	11 6, 12.5	.27288	17	172 1256	EK
Lawlers, Secondary	28 05.2 S	120 30	May 1, 12	17.4	0 11.0 E					*172*		EK
Yalgoo	28 20 6 S	116 40	Apr 18, 12			16 8	60 48 6 S				172 12	EK
			Apr 19, 12	9.9, 11 5	1 45 6 W			10 4, 11 2	.27246	17		EK
Goondiwindi	28 32 1 S	150 18	Jul 26, 13	10 5, 12 1	9 10 2 E	14 9	57 57.5 S	10 9, 11.8	.29395	17	172 156	EK
Dirranbandi	28 34.0 S	148 13	Jul 25, 13	9.0	7 49 6 E	7 6	58 11 9 S	9 4	.29263	17	172.12	EK
Laverton	28 37 5 S	122 26	Mar 28, 12	14 6, 16 1	0 41 6 W	11 1	61 17 3 S	15 0, 15 7	27534	17	172 125	EK
Boorthanna	28 37.7 S	135 53	Aug 17, 11	10 1, 11 8	3 33 2 E	13 9	59 37 3 S	10 6, 11 4	28571	9	41.56	K&W
Byron Bay	28 39 2 S	153 36	May 9, 13	14 5, 16 0	9 17 7 E	11 7	57 29 8 S	15 0, 15 7	.29444	17	172 1256	EK
Geraldton	28 47 0 S	114 37	Apr 16, 12			15 9	61 57 5 S				172 125	EK
			Apr 17, 12	10 3, 12 0	3 27 2 W			10 8, 11 7	26196	17		EK
Tenterfield	29 04.3 S	152 02	Apr 24, 13	13.0, 14 4	9 04 0 E	16 0	58 02.2 S	13 5, 14 1	29304	17	172 125	EK
Mingenew	29 12.4 S	115 26	Apr 15, 12	13 6, 15.0	3 50 9 W	11 2	62 32 8 S	14 0, 14 6	25848	17	172 1256	EK
Coward Springs	29 24 2 S	136 49	Aug 18, 11	10 5, 12 9	4 01 0 E	13 7, 15 2	60 24 7 S	11 2, 12 2	.28078	9	41 56	K&W
			Aug 18, 11			16 5	60 25 2 S				41 6	K&W
Moree	29 28 S	149 50	May 27, 13	11 2	8 30 1 E	12.4	59 06 3 S	11 5	28741	17	172 12	EK
Hergott Springs	29 39 1 S	138 02	Aug 16, 11	10 2, 12 5	5 13 8 E	11 0	60 29 9 S	10 8, 12 0	.28010	9	41.56	K&W
Menzies	29 41 0 S	121 04	Mar 29, 12	16 5	1 21 0 W			16 8, 17.4	26174	17		EK
			Mar 30, 12			10 4	62 32 0 S				172 1256	EK
Menzies, Secondary*	29 41.0 S	121 04	Mar 30, 12	11 5	1 10 W					*172*		EK
Wanaaring	29 42.3 S	144 08	Jun 14, 13	12 0	7 01 3 E	11 3	59 51 8 S	12 2	.28252	17	172 1	EK
Milparinka	29 45 0 S	141 54	Jun 21, 13	13.6, 14 8	6 24.8 E	12 2	60 13 4 S	14 0, 14 5	.28097	17	172.1256	EK

[1]From oscillations only.
*Local disturbance. The two declinations at station Mount Magnet *B* were obtained at points less than 1 foot apart, showing great disturbance

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	γ			
Walgett	30 01 2 S	148 08	May 29,'13	15 5	8 11 9 E	16 5	59 46 9 S	15 8	28255	17	172 12	EK
Farina, *B*	30 04 3 S	138 16	Aug 24, 11	10 1, 10 4	6 01 8 E					9		ENW
Farina, *A*	30 04 5 S	138 17	Aug 23, 11	9.7, 11 5	5 50 8 E			10 3, 11 1	.27752	9		K&W
Farina, Secondary	30 04 5 S	138 17	Aug 23, 11			11 2	60 54 2 S				41 56	ENW
Bourke	30 05 0 S	145 57	Jun 11, 13	14 2, 15 4	7 33 3 E			14 5, 15 1	28058	17		EK
			Jun 12, 13			10 2	60 10 5 S				172 156	EK
Bourke, *1*	30 05 0 S	145 57	Jun 12, 13	11 4	7 29 7 E					*172*		EK
Woolgoolga	30 07 2 S	153 12	May 5, 13	14 5, 15 9	9 19 9 E	12 3	59 09 3 S	14 9, 15 5	28592	17	172 1256	EK
Narrabri	30 18 6 S	149 48	May 28, 13	14 2	8 47 0 E	12 4	59 58 4 S	14 5	28166	17	172 1256	EK
Armidale	30 31 4 S	151 41	Apr 23, 13	14 5, 15 8	9 10 6 E	11 2	59 45 6 S	14 9, 15 5	28248	17	172 1256	EK
Moora	30 38 0 S	115 59	Apr 12, 12	14 6, 16 3	4 39 0 W	11 4	63 48 2 S	15 2, 16 0	.25132	17	172 1256	EK
Beltana	30 48 3 S	138 24	Aug 25, 11	13 2, 15 5	5 32 4 E			13 7, 14 7	27247	9		K&W
			Aug 26, 11			11 5	61 34 2 S				41 56	K&W
Beltana, Secondary	30 48 3 S	138 24	Aug 25, 11			15 5	61 35 6 S				41 56	EK
Coonamble	30 57 1 S	148 24	Jun 6, 13	15 5, 16 5	8 41 1 E			15 8, 16 3	27829	17		EK
			Jun 7, 13			10 2	60 45 8 S				172 1256	EK
Coolgardie	30 57 2 S	121 11	Mar 26, 12	15 5, 17 0	1 30 6 W	11 3	63 28 9 S	15 9, 16 6	25616	17	172 1256	EK
Boorabbin	31 12 8 S	120 20	Mar 20, 12	13 8, 15.4	2 01 0 W	11 2	63 59 1 S	14 3, 15 0	.25316	17	172.1256	EK
Southern Cross	31 13 8 S	119 21	Mar 19, 12	13 0, 14 6	2 13 7 W	16 3	64 06.0 S	13 5, 14 3	25142	17	172 12	EK
Werris Creek	31 21 0 S	150 39	Apr 22, 13	14 3, 15 6	8 53 0 E	11 0	61 04.2 S	14 6, 15 3	.27540	17	172.1256	EK
Nanwoora	31 22 5 S	131 34	Sep 26, 11	16 2	2 04 1 E	17 7	62 29.5 S	16 6	26962	17	178 12	EK
White Wells	31 26 1 S	130 59	Sep 27, 11	17.0	2 29 3 E			17 4	26826	17		EK
			Sep 28, 11			6 4	62 55.8 S				178 12	EK
Port Macquarie	31 26 3 S	152 55	Apr 16, 13	13 2, 14 5	8 55 6 E	11 2	60 46.6 S	13 5, 14 2	27770	17	172 1256	EK
Diamond Drill Tank	31 27 4 S	129 33	Sep 29, 11			17 8	63 12.3 S				178 78	EK
			Sep 30, 11	7 5, 9.4	1 06.0 E			8 0, 8 9	26450	17		EK
Cundalabbie Tanks	31 27.5 S	130 20	Oct 4, 11	17 4	2 35 2 E			17.8	26109	17		EK
			Oct 5, 11			6 1	63 30.6 S				178 12	EK
Merredin	31 28 3 S	118 19	Mar 17, 12	14 4, 15 8	3 23 0 W			14 8, 15.5	.25024	17		EK
			Mar 18, 12			10 3	64 19 6 S				172 1256	EK
Cobar	31 29 9 S	145 49	Jun 26, 13	15 4	7 41 1 E			15 8	27282	17		EK
			Jun 27, 13			7 4	61 36 2 S				172.12	EK
Wilcannia	31 33 7 S	143 23	Jun 16, 13	13 8, 15 3	6 59 6 E	11 1	61 59.6 S	14 3, 15 0	27005	17	172.1256	EK
Wilcannia, *1*	31 33 7 S	143 23	Jun 23, 13	10 5	6 59.3 E					*172*		EK
Nyngan	31 34 0 S	147 11	Jun 28, 13	9 9, 11 1	7 13.8 E	11 9	61 26 0 S	10 3, 10 8	27260	17	172 1256	EK
Colona	31 37 6 S	132 05	Oct 7, 11	16 2	3 02 9 E	17.6	63 33 3 S	16 6	25977	17	178 12	EK
Northam	31 38 6 S	116 41	Mar 15, 12	10 1, 11 4	4 30.0 W	15 1	64 43 4 S	10 4, 11.1	24453	17	172 1256	EK
Eucla	31 43 8 S	128 53	Oct 2, 11	9 5, 11 1	1 44 4 E	15 1	63 32 0 S	10 0, 10 7	25951	17	178 1278	EK
Broken Hill Reservoir	31 53 2 S	141 37	Sep 7, 11	11 5, 14 3	5 48 2 E	16 7	62 35 5 S	12 3, 13 6	26606	9	41 56	ENW
Hawker	31 53 2 S	138 26	Aug 29, 11	11 2, 13 1	5 50 4 E	10 0	63 05 2 S	10 8, 12 2	26244	9	41 56	ENW
Bayswater, *A*	31 55 2 S	115 55	Feb 14, 12	13 1, 14 6	4 41 6 W	14 3	64 51 4 S	13 5, 14 3	24422	17	172 12	EK
Bayswater, *B**	31 55 2 S	115 55	Feb 14, 12	10.9, 12 6	6 02 8 W					17		EK
Bayswater, *C**	31 55 2 S	115 55	Feb 14, 12	10 6	4 45.8 W					17		EK
Yalata Head Station	31 56 3 S	132 20	Oct 9, 11	9.6, 11 3	2 50 8 E	13 6	63 55.7 S	10 1, 10 8	.25600	17	178 12	EK
Broken Hill	31 57 8 S	141 27	Sep 10, 11	10.2, 10 4, 16 0	6 18 1 E	11 4	62 30 2 S	16 6, 17 5	.26710	9	41 56	ENW
Perth	31 58 0 S	115 50	Feb 16, 12	9 8, 12 6	4 45 0 W	14 7	64 55 1 S	10 8, 12 2	.24356	17	172 156	EK
Rottnest Island	32 00 2 S	115 33	Feb 17, 12	14 2, 15.6	4 38 1 W			14.6, 15 2	24293	17		EK
			Feb 18, 12			10 0	65 01 6 S				172.1256	EK
Cockburn	32 05 1 S	141 00	Sep 4, 11	10 6, 13 6	6 14 3 E			11 2, 13 1	26446	9		ENW
			Sep 5, 11			10 8	62 32 0 S				41.56	ENW
Ceduna	32 08 2 S	133 36	Sep 21, 11	10.0, 11.4	3 50.6 E	14 0	63 47 4 S	10.5, 11 1	25785	17	178.12	EK
Norseman	32 12 2 S	121 48	Mar 23, 12	14 5, 15 9	1 29 6 W	16 8	64 46 8 S	14 9, 15 6	24743	17	172.1256	EK
Dubbo, *A*	32 14 3 S	148 35	Jun 9, 13	10 6, 12 0	7 08 4 E	13 1	61 38 0 S	11 0, 11 8	27941	17	172.1256	EK
Dubbo, *1*	32 14 3 S	148 35	Jun 9, 13	14 1	4 05 1 E					*172*		EK
Dubbo, *B*	32 14.9 S	148 37	Jun 30, 13	10.6, 11.9	8 47 5 E	14.6	62 09 9 S	10 9, 11 5	.26979	17	172 256	EK
Olary	32 17 1 S	140 20	Sep 2, 11	10.0, 13.2	6 10.2 E	15.4	63 32 4 S	10 6, 12.1	25706	9	41 56	ENW
Menindie	32 23 9 S	142 26	Jun 18, 13	9 3, 10 6	6 50 4 E	11.5	63 02.3 S	9.6, 10 2	26412	17	172.1256	EK
Quorn	32 31 4 S	138 02	Aug 14, 11	9 5, 11 5	6 09.8 E	14 6	63 33.8 S	10 0, 10 9	.26034	9	41 56	K&W
Yunta	32 35 2 S	139 33	Sep 1, 11	10.9	6 01.8 E	15 8	63 23 6 S	12 3, 17 3	26119	9	41 56	ENW
			Sep 11, 11	17.9	6 01.6 E					9		ENW
East Maitland	32 44 9 S	151 34	Apr 21, 13	14 4, 16.8	9 34 1 E	11.1	62 04 3 S	14 8, 16 0	26980	17	172 1256	EK
Flinders	32 47 9 S	134 11	Sep 18, 11	9 0, 10 7	3 15.6 E	13 8	64 16 6 S	9 5, 10 2	.25712	17	178.1278	EK
Ivanhoe	32 54 2 S	144 19	May 22, 13	9.4	7 17.5 E	16.0	63 17 5 S	9.8	.26258	17	172 12	EK
Narrogin	32 55 8 S	117 10	Mar 5, 12	15.0, 16.9	5 21.5 W			15 6, 16 5	23530	17		EK
			Mar 6, 12			9 7	66 06 6 S				172 12	EK
Petersburg	32 58 4 S	138 48	Sep 13, 11	9 6, 13 2	5 42.8 E	15 7, 16 2	63 58 6 S	10.2, 12 3	25708	9	41 56	ENW

*Artificial local disturbance.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Condobolin	33 04 8 S	147 09	Jun 4,'13			16 3	63 02 2 S			.	172 12	E K
			Jun 5, 13	9 6, 10 9	7 51 8 E		.	10 0, 10 6	26402	17		EK
Port Pirie, *A*	33 11 3 S	138 01	Sep 15, 11	10 3, 13 5	6 21 0 E			11 0, 12 3	.25894	9		ENW
			Sep 16, 11	9 5, 9 7	6 18 5 E	11 0	64 01 4 S			9	41 56	ENW
Port Pirie, *B*	33 11 3 S	138 01	Sep 16, 11	14 4, 14 6	6 24 0 E	.	.	15 4	25833	9		ENW
Orange	33 17 6 S	149 07	Jun 3, 13	14 7, 16 0	9 10 2 E	11 3	63 02 6 S	15 0, 15 6	26304	17	172 1256	EK
Talia	33 19 2 S	134 50	Sep 15, 11	10 1, 11 7	4 15 2 E	14 2	64 59 8 S	10 5, 11 2	25051	17	178 1278	EK
Bunbury	33 19 5 S	115 38	Feb 21, 12			18 1	66 08 0 S	.	.		172 1256	EK
			Feb 22, 12	9 4, 10 9	5 46 3 W	.		9 9, 10 6	.23542	17	...	EK
Hillston	33 30 0 S	145 33	May 23, 13	9 7, 11 1	7 47 8 E	14 2	63 40 6 S	10 1, 10 8	25977	17	172 1256	EK
Burra	33 40 7 S	138 55	Aug 11, 11	14 6, 16 7	6 00 6 E	15 5	64 26 6 S	15 2, 16 2	.25452	9	41 56	K&W
Cowell	33 40 9 S	136 54	Sep 22, 11	9 9, 12 6	3 52.1 E	6 9	65 01 0 S	10 5, 11 8	25108	9	41.56	ENW
Katanning	33 41 3 S	117 33	Mar 4, 12	14 4, 15 8	4 21 8 W	17 3	66 34 2 S	14 8, 15 4	.23369	17	172.1256	EK
Red Hill, *A*	33 44.5 S	151 04	Mar 4, 13	.	.	15 3	63 12 2 S	...		..	172 1256	EK
			Mar 6, 13	10 5, 14 4	9 21.0 E	.	.	12 1, 13 6	26249	17	...	EK
			Mar 7, 13	11.3, 15 0	9 22.7 E	...	...	13 4, 14 4	26244	17	...	EK
Red Hill, *B*	33 44.5 S	151 04	Mar 3, 13	13.4, 15.9	9 22 1 E	.	.	14 4, 15 3	26234	17	...	EK
			Mar 4, 13	10.8, 14.2	9 20 0 E	...	...	11 3, 13 2	26220	17	......	EK
Garden Island (Sydney Har.)	33 51.9 S	151 14	Mar 28, 13	10 5, 12 8	9 35 9 E	14 8	63 17 0 S	11 1, 12 4	26200	17	172.1256	EK
Wallaroo	33 56 3 S	137 36	Sep 19, 11	10 3, 12 9	5 49 2 E	16 1	65 00 1 S	10 8, 12 1	.26578	9	41 56	ENW
Bridgetown	33 57 4 S	116 09	Feb 23, 12	11 0, 12 8	5 35.2 W	15 0	66 42 7 S	11 7, 12.4	23097	17	172 1256	EK
Morgan	34 02 5 S	139 40	Oct 26, 11	8 9, 10 4	6 21 2 E	14 1	64 57 8 S	9 4, 10 1	.25077	17	178 1278	EK
Mount Hope	34 06.3 S	135 20	Sep 12, 11	14 1, 16 0	4 24 2 E	..		14 6, 15 5	.24677	17		EK
			Sep 13, 11	..	..	10 0	65 23 9 S	...		.	178 1278	EK
Renmark	34 10.1 S	140 45	Oct 28, 11	14 0, 15 4	6 31 3 E	16 8	65 00 7 S	14 4, 15 1	.25074	17	178 12	EK
Port Wakefield	34 10 6 S	138 10	Oct 11, 11	...		16 6	65 48 9 S	...	...	..	41 56	ENW
			Oct 12, 11	9 5, 11 3	5 46 1 E	...	.	10 1, 10 9	.24690	9	......	ENW
Mildura	34 11.8 S	142 11	Nov 1, 11	14 0, 15 3	6 43 4 E	11 2	64 48 0 S	14 3, 15 0	25280	17	178 12	EK
Hay	34 30 5 S	144 51	May 20, 13	14.1, 15.4	7 41.0 E	11.3	64 45.2 S	14 5, 15 1	.25189	17	172.1256	EK
Harden	34 33.7 S	148 22	Feb 24, 13	10.3, 11.8	8 53 0 E	14 5	64 15 4 S	10 8, 11 5	25498	17	172 1256	EK
Port Lincoln	34 42.6 S	135 48	Sep 9, 11	14.8, 16 6	3 26.0 E	12.0	66 00 0 S	15 4, 16 1	.24406	17	178 1278	EK
Narrandera	34 44.3 S	146 34	May 17, 13	14 0, 15 2	8 23.3 E	16 6	64 41.4 S	14 4, 14 9	25224	17	172.1256	EK
Goulburn	34 45.8 S	149 44	Feb 26, 13	10.1, 11 5	9 08 2 E	14 8	64 19 7 S	10 5, 11 2	.25440	17	172.125	EK
Adelaide (Botanical Park)	34 55 3 S	138 37	Oct 18, 11	10 0, 12 5	5 35 2 E	16 4	66 04.8 S	10.6, 11 7	24280	9	178 12	ENW
Adelaide (South Park)	34 56 2 S	138 36	Aug 8, 11	10.8, 13.6	5 37 0 E	14.5	66 05.4 S	12 4, 12 7	24319	9	41.56	K&W
Albany	35 01.3 S	117 55	Mar 1, 12	...	...	17.0	67 16.8 S	..	.	...	172.1256	EK
			Mar 2, 12	10 6, 12.6	5 14 8 W	...	...	11 1, 11 8	22910	17	....	EK
Edithburgh	35 05 9 S	137 46	Oct 1, 11	9 9, 13.4	5 10 4 E	16.6	66 24.8 S	10 6, 12 9	23940	9	41.56	ENW
			Oct 2, 11	9 0, 9 2	5 05 6 E	...	...	...	.	9	...	ENW
Wagga Wagga	35 06.2 S	147 23	Feb 22, 13	10 1, 11 5	8 13 2 E	14.0	64 57 3 S	10.5, 11.2	.25027	17	172 1256	EK
Murray Bridge	35 07 2 S	139 16	Aug 4, 11	10 2, 13 2	5 36 3 E	.	...	10 8, 12 2	24091	9	...	K&W
Murray Bridge, Secondary	35 07.2 S	139 16	Aug 4, 11	...	..	11 1	66 17 3 S	...	..	...	41.56	K&W
Pinnaroo	35 15 8 S	140 55	Oct 26, 11	10.3, 13 0	6 04 1 E	16.4	65 50.8 S	10 9, 12.6	.24421	9	41 56	ENW
Mt Pleasant	35 18.0 S	149 10	Apr 29, 13	14 7, 16.1	9 18 2 E	13.3	64 48.3 S	15 1, 15.8	.25150	17	172.126	EK
Mt. Stromlo*	35 19.5 S	149 00	Apr 28, 13	9 8, 11 2	8 47.1 E	12 3	64 54.2 S	10.2, 10 9	25092	17	172 1256	EK
Mt Stromlo, *1**	35 19.5 S	149 00	Apr 28, 13	15 1	9 26 7 E	...	...	..	..	*172*	...	EK
Mt Stromlo, *2**	35 19 5 S	149 00	Apr 28, 13	15 6	9 41 3 E	...	...	.		*172*	...	EK
Swan Hill	35 20.2 S	143 34	Jan 21, 13	11.0, 13 8	7 19 7 E	8 3	65 43 1 S	11 9, 13 1	24570	17	172.1256	FWC
Port Victor	35 31 8 S	138 37	Sep 29, 11	10 2, 12 5	5 46 8 E	8.0	66 36 6 S	11.0, 12 1	23753	9	41 56	ENW
Deniliquin	35 32 0 S	144 58	Jan 27, 13	14 5, 16 6	8 02 4 E	10 8	65 42 9 S	15 2, 16 1	.24586	17	172 1256	FWC
Woomelang	35 41.0 S	142 41	Nov 2, 11	13 4, 14 9	7 03 8 E	10 8	66 11 5 S	13 8, 14 5	24292	17	178.12	EK
Coonalpyn	35 41 9 S	139 53	Aug 3, 11	11 0, 12 8	5 46 6 E	10.4	66 21 7 S	11 6, 12 4	24044	9	41 56	K&W
Hog Bay	35 43 2 S	137 56	Oct 8, 11	8 8, 11.5	5 12 8 E	15 0	67 01 4 S	10 0, 10 8	23459	9	41 56	ENW
Harvey's Return	35 43.7 S	136 39	Oct 6, 11	10 4, 13.3	4 32.8 E	15.2	66 59 8 S	11 1, 12 7	.23406	9	41 56	ENW
Moruya	35 55 1 S	150 05	Mar 17, 13	10 4, 11.8	8 10 8 E	14 6	65 04 5 S	10 8, 11 4	25200	17	172 126	EK
Albury	36 05 1 S	146 55	Dec 15, 11	8 9, 10 4	8 30.5 E	11 3	65 58.4 S	9 3, 10 1	24359	17	172.1256	EK
Echuca	36 06 4 S	144 44	Jan 24, 13	13 9, 16 3	7 50.7 E	10 4	66 17 2 S	14 6, 15 8	24182	17	172.1256	FWC
Cooma	36 14.0 S	149 08	Mar 12, 13	13 8, 15 3	9 24 2 E	11.6, 12 1	65 47 2 S	14 2, 15 0	24476	17	172 1256	EK
Charlton	36 16 6 S	143 22	Jan 17, 13	14 9, 17 2	6 59.0 E	10.8	66 36 0 S	15 6, 17 2	23959	17	172.1256	FWC
Border Town	36 18 5 S	140 46	Aug 2, 11	13 2, 15.2	6 26 4 E	12 1	67 02 9 S	13 7, 14 7	.23616	9	41.56	K&W
Shepparton	36 22.6 S	145 24	Jan 30, 13	14.6, 17.6	8 15 7 E	10 9	66 23 9 S	15 6, 17 0	24096	17	172.126	FWC
Horsham	36 43 0 S	142 12	Aug 1, 11	14 1, 15 7	7 21.2 E	13 0	67 08 4 S	14 5, 15 2	.23555	9	41 56	K&W
Bendigo	36 44 4 S	144 19	Jan 15, 13	14 1, 17 1	7 50 0 E	11.0	66 52.0 S	15 1, 16 4	23699	17	172.1256	FWC
Mansfield	37 02 9 S	146 07	Feb 11, 13	14 3, 16 8	8 28.7 E	10 7	66 55.9 S	15.1, 16 3	23658	17	172 1256	FWC
Eden	37 04 6 S	149 56	Mar 14, 13	14.9, 16.0	9 57.4 E	12 2	66 21 3 S	15 2, 15 7	24044	17	172 1256	EK
Omeo	37 06 3 S	147 36	Feb 5, 13	16.6	8 50.9 E	14.2	66 45.5 S	17 4, 18 5	23748	17	172 1256	FWC
Ararat	37 17 0 S	142 57	Jul 31, 11	9 9, 11 6	7 26 8 E	15 0	67 22 2 S	10 4, 11 1	.23343	9	41 56	K&W

*Local disturbance

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M T	Value	L M T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Ballarat	37 34 0 S	143 50	Jan 2,'13	. .	. ....	14 0 .	67 57 5 S	. . .	.		172 126	FWC
			Jan 3, 13	11 2, 14 4 . . .	6 50 0 E	. .	. . .	12 3, 13 7	.22998	17		FWC
Casterton	37 35 0 S	141 25	Dec 28, 12	13 7, 17 3 .	7 16 0 E			14.8, 16 5	22758	17		FWC
			Dec 29, 12	14 3, 16 8	7 15 9 E	12 5	68 06.8 S	15 0, 16.1	22792	17	172 1256	FWC
Casterton, Secondary	37 35 0 S	141 25	Dec 30, 12	11.0 .	7 15 9 E	. .	. . .		.	172		FWC
Water's Homestead	37 40 0 S	146 07	Feb 15, 13	15 7, 17.1	8 38 0 E	14 3 .	67 28 9 S	16 1, 16 8	23268	17	172 156	K&C
Bairnsdale	37 49 5 S	147 39	Feb 3, 13	10 8, 13 3 .	9 07 6 E	7.4	67 28 9 S	11 5, 12 7	.23312	17	172 16	FWC
Melbourne, *A*	37 49 9 S	144 58	Jul 19, 11	8 8, 10 4	8 05 4 E			9 3, 9 9	23094	9		K&W
			Jul 21, 11	9 9, 11 5	8 04 6 E		. .	10 5, 11 1	23108	9		K&W
			Jul 21, 11	12 4, 13 9 .	8 07 6 E		.	12 9, 13 6	23087	9		K&W
			Jul 22, 11	12 9	8 07 3 E		.	11 0, 12 2	23101	9		K&W
			Apr 4, 13	17 2	8 03 9 E			16 8	.23099	6	.	EK
			Apr 5, 13	14 8, 16 6 .	8 04 7 E		.	15 4, 16 2	23100	6		EK
			Apr 6, 13	10 5, 12 3 .	8 02 3 E			11 1, 11 9	23072	6		EK
			Apr 6, 13	13 4, 15 5	8 05 6 E		. .	14 1, 15.0	23090	17	. .	EK
			Apr 7, 13	9 8, 11 8 .	8 01 7 E	. .	. .	10 4, 11 2	23083	17	.	EK
			Apr 9, 13	. .		. .	. .	10 1, 11 9	23104	17		EK
			Apr 9, 13			.	.	12 9	23084	17	.	EK
Melbourne, *B* .	37 49 9 S	144 58	Jul 18, 11	10 6, 13 6 .	8 06 0 E			11 6, 12 6	23111	9		K&W
			Jul 19, 11	11 6	8 05 6 E		.	12 3, 13 2	23085	9		K&W
			Jul 20, 11	10 8, 13 0	8 04 4 E		.	11 4, 12 4	23099	9		K&W
			Jul 24, 11	9 7, 12 2	8 04 2 E		. .	10 4, 11 4	.23096	9		K&W
			Jul 24, 11	13 7, 15 9 .	8 07 6 E	. .		14 3, 15 2	.23103	9		K&W
			Jul 25, 11	9 8, 12 0	8 04 1 E	.	.	10 5, 11 4	23123	9		K&W
			Feb 1, 12			14 1, 15 4	67 42 7 S	. . . .	.	.	172 1256	EK
			Feb 2, 12			11 9	67 43 1 S	. .	.		172 1256	EK
			Apr 4, 13	15 2, 17 2 .	8 05 0 E	.	.	16 0, 16 8	23096	17	. .	EK
			Apr 5, 13	14 8, 16 6	8 04 5 E	. .	. .	15 4, 16 2	23102	17		EK
			Apr 6, 13	10 6, 12 3 .	8 02 5 E	.	.	11 1, 11 9	.23082	17		EK
			Apr 6, 13	13 4, 15 5 .	8 05 6 E	. .	. .	14 1, 15 0	23102	6	.	EK
			Apr 7, 13	9 8, 11 8	8 01 2 E			10 4, 11.2	.23095	6		EK
			Apr 8, 13	.	.	15 5	67 42 5 S		.		172 156	EK
Melbourne, Dip Pier	37 49 9 S	144 58	Dec 11, 11			11 6, 13 4	67 44 3 S		.		41 56	EK
			Dec 11, 11	.		15 0	67 44 7 S	. .	.		41.56	EK
			Dec 11, 11		.	11 5, 15 0	67 44 4 S			.	172 1256	EK
			Feb 1, 12	.	.	11 5	67 44 3 S	. .	.		172 1256	EK
			Feb 2, 12		.	13 3 .	67 43 1 S	.	. .		172.1256	EK
			Apr 7, 13	. .		17 3 .	67 43 1 S	. . .	.	. .	172 156	EK
			Apr 8, 13		.	12 1	67 43 3 S		.		172 156	EK
Melbourne, Earth-Inductor Pier	37 49 9 S	144 58	Feb 2, 12	.		14 7	67 42 1 S		.	.	172 1256	EK
Geelong	38 09 0 S	144 23	Dec 17, 12			16 3	68 02 7 S		. .	.	172 126	EK
			Dec 18, 12	9 4, 11 1	7 52 0 E	. .	.	9 9, 10.7	22771	17		EK
Geelong, Secondary	38 09.0 S	144 23	Dec 17, 12	17 5	7 58 3 E	. . .	. . . . .	. . . . .		172		EK
Portland.	38 20 6 S	141 37	Dec 24, 12			12 2	68 44 8 S	. . . .	.	.	172 126	FWC
			Dec 26, 12	9 9, 14 8, 16 9	6 30 2 E	.	. . . .	11.4, 13 5	22226	17		FWC
			Dec 26, 12	. . . .		. .		14 9, 16 2	22238	17		FWC
Portland, Secondary	38 20 6 S	141 37	Dec 24, 12	14 4 .	6 49 0 E	. .	. .			172		FWC
Warrnambool	38 23 6 S	142 29	Dec 21, 12	13 9, 15 3	7 10.4 E	10.9 .	68 30 6 S	14 3, 15 0	22378	17	172 126	K&C
Warrnambool, Secondary	38 23 6 S	142 29	Dec 21, 12	17 2 . .	7 03.7 E				.	172		FWC
Alberton	38 37 4 S	146 40	Jan 11, 13	15 4, 17 9 .	9 00.7 E	10 8	68 08 5 S	16 2, 17 3	22764	17	172 126	FWC
Beech Forest	38 37 5 S	143 34	Dec 19, 12	.	.	16.3	68 31 4 S				172 126	EK
			Dec 20, 12	9 2, 10 8	7 33 4 E	.		9 7, 10 5	22358	17	.	EK
Longford	41 35 9 S	147 08	Dec 22, 13	14 0, 15 9 .	9 22 4 E		.	14 6, 15 5	20610	14		EK
			Dec 23, 13	.	. .	14.9 .	70 40 0 S	.			14 12	EK
Dee Bridge	42 17.8 S	146 40	Dec 26, 13	11 5, 15 2	8 47.2 E	16 0 .	71 21 8 S	12 9, 14 7	20091	14	14 12	EK
Sorell .	42 47 6 S	147 33	Dec 30, 13	14 2, 16 0 .	9 46 5 E	16.4 .	71 22 2 S	14 6, 15 6	20090	14	14 1	EK
Hobart, *A**	42 52 0 S	147 22	Nov 13, 11	14 1, 17 1	7 46.8 E		.	16.5 .	19597	6		JMB
			Nov 14, 11	8 2, 11 3	7 38.8 E	.	. .	9 1, 10.5	.19576	9	.	JMB
			Nov 15, 11	.		11 4, 13 4	71 53 1 S				172 1256	EK
			Nov 15, 11			15 5	71 53 1 S	.	.		178 1278	EK
			Nov 16, 11			12.7, 15 6	71 53 9 S	. . .	.		178.1278	EK
			Nov 17, 11	15 1, 15 4, 15 8	7 45 1 E	10 7, 12 0	71 53 9 S			17	178 1278	K&W
			Nov 17, 11	16 4, 16.7, 17 0	7 43 7 E	14.1	71 53 5 S	.		17	178 12	K&W
			Nov 18, 11	11 2, 14 3	7 44 2 E		.	12 2, 13 5	19590	17	. .	JMB
			Nov 20, 11	.	.	.	.	10 4, 11 2	19594	17	.	EK
			Nov 20, 11				.	11 7, 12 9	.19594	17	.	ENW

*Local disturbance

AUSTRALASIA.

AUSTRALIA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Hobart, *A**—*Continued*	42 52 0 S	147 22	Nov 20,'11	.... .	... .	.		15 7, 16 7	.19606	17	..	W&K
			Nov 21, 11	. ... .	. . ..	. .		10.7, 12 5	.19590	17	.	EK
			Nov 21, 11	.	. ..	. . .	.	15 0, 16 2	.19610	17	. .	W&K
Hobart, *B**	42 52 0 S	147 22	Nov 13, 11	14 0, 17 1 . ..	6 45 3 E	..		14 9, 16 3	.19268	9	.. ..	ENW
			Nov 14, 11	8.2, 11 3 ..	6 37 6 E	. .	.	9 0, 10 5	.19260	17	.. .	ENW
			Nov 15, 11	. . ..	. .... .	11 4, 13 4	72 17 8 S	.		.. .	178 1278	ENW
			Nov 15, 11	. .	...	15 5 . .	72 17 4 S	. .	.	. ..	172.1256	ENW
			Nov 16, 11	. . . .	...	12 7 .	72 19 4 S		. .	..	172 1256	ENW
			Nov 18, 11	11 3, 14 2 . .	6 42.4 E	. . .		12 3, 13 4	.19274	6	. .	ENW
Hobart, *C**	42 52 0 S	147 22	Nov 13, 11	14 1, 17 1	8 26 2 E	.. .	.	14 9, 16 3	19760	17	. .	EK
			Nov 14, 11	8 2, 11 3	8 18 0 E	.. . .	.	9 0, 10 5	.19756	6	...	EK
			Nov 18, 11	11 3, 14 3 ...	8 23 0 E	. .	.. ..	12 3, 13 5	.19763	9	...	EK

NEW ZEALAND.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M T	Hor Intensity: Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Nelson, *A*.	41 16 9 S	173 17	Jan 9,'12	14 4, 16 4 ..	16 23 2 E	11 8 . ..	66 27 4 S	15 2, 16.0	23589	17	172 1256	EK
Nelson, *B*....	41 15 9 S	173 17	Jan 10, 12	13.4, 14 8 ..	15 56.8 E	15.6 ...	66 27 7 S	13 8, 14.5	.23618	17	172.12	EK

*Local disturbance

EUROPE.

BULGARIA.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Sofia	42 40 7 N	23 18	Jul 9,'11	9 1, 11 2 ...	4 45 2 W	13 9 ..	57 33 8 N	9 8, 10 7	.23470	7	202 125	WHS
Burghas	42 30 0 N	27 28	Jul 2, 11	8 8, 10 7 .	0 49 0 W	14 5	56 06 0 N	9 3, 10 2	24078	7	202 125	WHS
Nova-Zagora	42 29 2 N	26 01	Jul 4, 11	8 5, 10 2	3 10 3 W	14 2	57 13 3 N	9 0, 9 8	.23717	7	202 125	WHS
Philippopolis	42 08 7 N	24 47	Jul 6, 11	9 8, 11 5	2 42 8 W	14 1 .	58 38 7 N	10 3, 11 1	.23592	7	202 125	WHS

CRETE.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	°	h h	Γ			
Candia	35 19 4 N	25 08	Sep 3,'11	9 6, 11 4	4 09.0 W	14 5 ..	48 45 7 N	10.2, 11 1	27296	7	202 1257	WHS

GREAT BRITAIN.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Truro	50 15 4 N	354 58	Oct 2,'13	12 8, 14 6	17 21 0 W	11 2	66 28 8 N	13 4, 14 3	18772	14	14 1256	C II
			Oct 3, 13	10 0, 11 4 .	17 16 8 W	12 8	66 27 8 N	10 4, 11 0	18752	14	14 1256	C II
Falmouth, *A*	50 09 6 N	354 57	Sep 16, 13	11 2, 13 8, 14 8	17 14 1 W		.	12 2, 13 4	18792	4	...	C II
			Sep 16, 13	16 9, 17 0	17 10 8 W	..	.	15 2, 16 2	18802	4	...	C II
			Sep 17, 13	9 0, 10 9 .	17 12 4 W	.	...	9.7, 10 6	18782	4	...	C II
			Sep 17, 13	...	.	...	..	12.1, 13.4	.18805	2	..	C II
			Sep 17, 13	...		...	...	14 7, 15 5	.18816	2		C II
			Sep 17, 13	...	...	...	...	16 6, 17 4	.18810	2	.	C II
			Sep 18, 13	...	...	...	...	9 7, 10 5	.18792	2	.	C II
			Sep 18, 13	...	...	...	...	11.5, 12 9	.18784	2	.	C II
			Sep 18, 13	...	...	...	...	14 0, 14 8	.18803	2	..	C II
			Sep 19, 13	...	...	10.7, 11 4	66 26 3 N				EI 3	C II
			Sep 19, 13	...	...	11 9, 12 4	66 27.3 N		.		EI 3	C II
			Sep 19, 13	...	...	13 3, 13 8	66 27.4 N		.	..	EI 3	C II
			Sep 19, 13	...	...	14.3, 14 8	66 26.9 N	.	.	.	EI 3	C II
			Sep 20, 13	...		10 2, 10 6	66 26 0 N	.	...		EI 2	C II
			Sep 20, 13	...	..	10 8, 11 1	66 26.2 N	...	..		EI 2	C II
			Sep 20, 13	...	.	11.4, 11 8	66 26 2 N	..	..		EI 2	C II
			Sep 20, 13	...		12 6, 13 0	66 26.0 N		...		EI 2	C II
			Sep 22, 13	...	..	9 6, 9 9	66 26.8 N	.	..		EI 2	C II
			Sep 22, 13	...		10 3, 10 9	66 27 4 N	.	..	..	EI 2	C II
			Sep 22, 13	...	...	11 4, 12 8	66 26 6 N	.	.		EI 2	C II
			Sep 22, 13	...	...	13 0, 13 2	66 25 6 N	...	.	...	EI 2	C II
			Sep 24, 13	9 9, 11 4, 12 3	17 13 5 W	...	...	10 5, 11.2	18779	4	.	C II
			Sep 24, 13	13 4, 13 6, 14 7	17 14 2 W	..	...	12 6, 13 1	18792	4	.	C II
			Sep 24, 13	..	...		...	13 9, 14 4	18792	4	..	C II
			Sep 30, 13	...	.	15 0, 15 6	66 24 9 N		.		EI 3	C II
Falmouth, *B*	50 09 6 N	354 57	Sep 18, 13	8 9, 10 8, 11 2	17 10.7 W	.		9.6, 10 5	18788	4	..	C II
			Sep 18, 13	13 3, 13 6, 15 2	17 15 7 W	...		11 5, 12 8	18781	4		C II
			Sep 18, 13	.		.	..	14.0, 14 8	.18798	4	..	C II
			Sep 22, 13	..		9.8, 10 6	66 27.1 N	.	..	...	EI 3	C II
			Sep 22, 13	...	...	12.1, 13.1	66 26 1 N	...	..	.	EI 3	C II
			Sep 22, 13		.	14 9, 15 5	66 26 5 N	...		.	EI 3	C II
			Sep 22, 13	...	.	16 0, 16 4	66 26.9 N	...	..	..	EI 3	C II
			Sep 24, 13	9 9, 11.4, 12 3	17 12 4 W	..	...	10.4, 11.1	18792	14	..	C II
			Sep 24, 13	13 4, 13 6, 14 7	17 12 8 W	..	..	12 6, 13 1	18792	14		C II
			Sep 24, 13	...	.	...	.	13 9, 14 4	18796	14	..	C II
			Sep 25, 13	...	.	9 4, 10 0	66 26 1 N	..	...	..	EI 3	C II
			Sep 25, 13	..	..	10.9, 11 9	66 25 5 N	.	..	...	EI 3	C II
			Sep 25, 13	..		12 6 .	66 25 1 N	..	..	...	EI 3	C II
Falmouth, *C*	50 09 6 N	354 57	Sep 15, 13	15 0, 16 9, 17 8	17 10 8 W	...	...	.	...	4		C II
			Sep 16, 13	13 8, 14 8	17 11 7 W	..	.	12 2, 13 4	.18775	2	..	C II
			Sep 16, 13	16 9, 17.1	17 08.2 W			15 2, 16.2	18783	2	...	C II
			Sep 17, 13	11 6, 13 8, 14 3	17 15 4 W			12 1, 13 4	.18789	4	...	C II
			Sep 17, 13	15 8, 16 2, 17 7	17 10 7 W		..	14 7, 15 5	.18805	4	..	C II
			Sep 17, 13	...	.		..	16 6, 17 3	18799	4		C II
			Sep 17, 13	9 1, 10 9, 11 6	17 12 4 W	.	..	9 7, 10 6	.18772	2	.	C II
			Sep 17, 13	13.8, 14 3, 15 8	17 12 5 W	...	...	..	...	2	...	C II
			Sep 17, 13	16.2, 17 7 .	17 09.4 W	...	..	...	..	2		C II
			Sep 18, 13	8 9, 10 8, 11 2	17 09 6 W		.	.	.	2	...	C II
			Sep 18, 13	13 3, 13.6, 15.2	17 14 6 W	...	...	...	..	2	...	C II
			Sep 19, 13	...	...	11.1, 11 6	66 26 7 N	..	...	..	EI 2	C II

EUROPE.

GREAT BRITAIN—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M. T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Falmouth, *C—Continued*	50 09 6 N	354 57	Sep 19,'13			12. 0, 12 3	66 26 8 N				EI 2	C II
			Sep 19, 13			13 2, 13 5	66 26 2 N				EI 2	C II
			Sep 19, 13			13 9, 14 2	66 26 2 N				EI 2	C II
			Sep 20, 13			9 9, 10 5	66 27 3 N				EI 3	C II
			Sep 20, 13			11 1, 11.6	66 27.7 N				EI 3	C II
			Sep 20, 13			12 2	66 27 5 N				EI 3	C II
			Sep 20, 13			12.9, 13 4	66 28 0 N				EI 3	C II
			Sep 30, 13			14.9, 15 2	66 25 2 N				EI 2	C II
			Sep 30, 13			15.4, 15 7	66 25 2 N				EI 2	C II
Falmouth Observatory	50 09.0 N	354 55	Sep 22, 13			10 0, 10 9	66 19.7 N				201 12	C II
			Sep 22, 13			11 8	66 22 6 N				201.12	C II
			Sep 24, 13	10 3, 12 0, 13 1	17 15.4 W			10 7, 11.7	.18794	2		C II
			Sep 24, 13	14 5, 14.9, 16 4	17 14 0 W			13 5, 14 2	.18808	2		C II
			Sep 24, 13					15.2, 16.0	18802	2		C II
St Anthony	50 08 N	355 00	Oct 2, 13	13 7, 15.7	17 23 6 W	11 6, 11 9	66 26 0 N	14.3, 15.2	18783	2	EI 2	C II
			Oct 3, 13	12 9, 14.8	17 24.5 W	16 5, 16 8	66 25 8 N	13.5, 14 3	.18786	2	EI 2	C II
Porthallow	50 04.3 N	354 55	Oct 2, 13	15 0, 16.4	17 16 1 W	10 4, 10 9	66 25 3 N	15 5, 16 1	18794	4	201.1	C II
			Oct 3, 13	9 3, 10.6	17 12 2 W	13 8	66 24 8 N	9 8, 10 4	18774	4	201 1	C II

GREECE.

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M. T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Corfu	39 38.2 N	19 56	Sep 15,'11	9.4, 11 2	5 49.6 W	14 4	54 21.2 N	9 9, 10.8	.24976	7	202 1257	WHS
Patras	38 15 4 N	21 46	Sep 11, 11	8 8, 10 5	5 09.2 W	14 1	52 35 9 N	9 2, 10 1	25712	7	202 1257	WHS
Kephisia	38 04 7 N	23 51	Aug 24, 11	8 8, 10.6	4 27.1 W	14 2	52 17.9 N	9 3, 10 2	25909	7	202 1257	WHS
Athens, *P*	37 58 3 N	23 43	Aug 16, 11			6 3, 7.0	52 09 2 N				202 12	WHS
			Aug 16, 11			7 9	52 08 9 N				202.12	WHS
			Aug 17, 11	6 4	4 28.8 W			7.3	26017	7		WHS
			Aug 18, 11	6.5, 17.4	4 29 3 W			7 2	.26013	7		WHS
			Aug 19, 11	7.0, 16.8	4 30.6 W			6 1, 7 7	25975	7		WHS
			Aug 19, 11					17 4	25985	7		WHS
			Aug 21, 11			17.7	52 10 8 N				202 12	WHS
			Aug 22, 11	6.4	4 28 1 W			7.2	26000	7		WHS
Athens, *T*	37 58 3 N	23 43	Aug 10, 11	16.7	4 30 3 W			17 8	.26093	7		WHS
			Aug 11, 11	7.5, 16.6	4 27.0 W			8 3, 17.4	.26062	7		WHS
			Aug 12, 11	6 4, 16.3	4 29.0 W			7.0, 16 9	.26070	7		WHS
			Aug 14, 11	5.8, 16.9	4 27.9 W			6 4, 17 6	26068	7		WHS
			Aug 22, 11			16.8, 17.9	52 03 9 N				202 12	WHS
			Aug 22, 11			18.7	52 02 6 N				202 12	WHS
			Aug 23, 11	9.2	4 28.9 W					7		WHS
Zante	37 46 5 N	20 55	Sep 8, 11	9 0, 10.8	5 29 8 W	14 4	52 07.9 N	9 5, 10 4	25892	7	202 1257	WHS

ITALY.

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M. T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Rome	41 57.5 N	12 28	Oct 25,'11	9.6, 11 2	8 43 8 W	13 9	57 29 4 N	10 0, 10 8	.23475	7	202.12	WHS
			Nov 7, 13	15 3	8 25 6 W			16 1	.23446	10		WFW
			Nov 8, 13	10 3, 13 4, 16 2	8 24 7 W			11 0, 13 9	.23458	10		WFW
			Nov 8, 13					15 6	23448	10		WFW
			Nov 10, 13			10 6, 11 4	57 29 6 N				202.1257	WFW
			Nov 10, 13			14 0, 14 8	57 30.8 N				202 1257	WFW
Terracina, *A*	41 17 7 N	13 15	Oct 21, 11	16 8, 17 0	8 22 5 W	15 1, 15.8	56 44.0 N			7	202 12	WHS
			Nov 13, 13					14 6, 15.4	23834	10		WFW
			Nov 13, 13					16.0, 16 2	23828	10		WFW
			Nov 15, 13			9.4, 10 3	56 43.4 N				202.1257	WFW
			Nov 15, 13			11.1, 11.9	56 42 9 N				202 1257	WFW
			Nov 15, 13			15.2, 16.0	56 43.0 N				202 1257	WFW
			Nov 16, 13	10.1, 10 4, 10.7	8 03 1 W	8 4, 9 1	56 42 6 N			10	202.1257	WFW
			Nov 16, 13	10.9, 11 3	8 04 4 W					10		WFW
Terracina, *B*	41 17.7 N	13 15	Oct 20, 11	10 6, 10.9, 11 2	8 22 4 W			14 8, 15 9	23818	7		WHS
			Oct 20, 11	11.5, 11.8	8 24.1 W					7		WHS
			Oct 21, 11			10 4, 11 0	56 42 6 N				202 12	WHS
			Nov 12, 13	11.0	8 03 3 W			14 3, 15.1	.23834	10		WFW
			Nov 12, 13					15 8, 16.5	23832	10		WFW
			Nov 13, 13	9 2, 9.5, 9 8	8 01.2 W	8 2	56 42 0 N			10	202 12	WFW

EUROPE.

ITALY—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Terracina, *B*—*Continued*	41 17 7 N	13 15	Nov 13,'13	10 2, 10 5, 10 8	8 02 1 W					10	. .	WFW
			Nov 13, 13	11 1	8 03 2 W				.	10	.	WFW
			Nov 16, 13		..	14.5, 15 2	56 42 9 N		.		202 1257	WFW
			Nov 16, 13			16 1	56 43.0 N		. .		202 57	WFW
			Nov 17, 13	9 8, 10 0, 10 3	8 01 9 W	8 0, 8 7	56 43.1 N		.	10	202 1257	WFW
			Nov 17, 13	10 6, 10 9	8 02 7 W					10	.	WFW
Messina	38 12 2 N	15 35	Nov 29, 13	16 4	7 05.0 W		.			10	.	WFW
			Nov 30, 13	10 6, 14.7	7 05 4 W	15 8, 16 5	53 05 5 N	13 3, 14 2	25409	10	202.1257	WFW
Palermo	38 07 4 N	13 19	Nov 19, 11	9 7, 11 4	8 13 2 W	14 2	53 11.2 N	10 3, 11 0	.25314	7	202 12	WHS
			Dec 6, 13	12 0, 15 3 .	7 55 1 W			12 6, 13 6	25286	10		WFW
			Dec 8, 13	10 6	7 53 9 W	14.5, 15 3	53 14 6 N		.	10	202 1257	WFW
			Dec 10, 13	10 7 ..	7 55 0 W			12 9, 13 8	.25322	10		WFW

MALTA.

Station	Latitude	Long East of Gr	Date	Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Valetta	35 53 2 N	14 25	Nov 11,'11	9 6, 11 5	7 37 4 W	14 5	50 29 9 N	10 2, 11 2	26456	7	202 1257	WHS

SERBIA.

Station	Latitude	Long East of Gr	Date	Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Nissa	43 18 7 N	21 55	Jul 14,'11	16 5, 18 2	4 57 9 W	14.0 ..	58 03 9 N	17 0, 17 8	23368	7	202 125	WHS

SPAIN.

Station	Latitude	Long East of Gr	Date	Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
San Roque	36 12 1 N	354 37	Mar 25,'12	9 7, 11 6	14 38 6 W	14 1	53 56 6 N	10 3, 11 2	25010	7	202 12	WHS
			Apr 11, 12	10 2	14 36 6 W			11 2	25007	13		DWB
			Apr 12, 12	11 8	14 40 1 W			.		13		DWB
			Apr 15, 12	9 7, 12.0 .	14 39 1 W	10 2, 16 3	54 00 6 N	. .		13	223 1356	DWB
			Apr 16, 12					9 6, 11 2	.24976	13	...	DWB

TURKISH EMPIRE.

Station	Latitude	Long East of Gr	Date	Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Mitrovitsa	42 53 9 N	20 52	Jul 18,'11			18 0	57 34 6 N		.		202 12	WHS
			Jul 19, 11	9 3, 11 1 .	5 09 8 W	.		9 8, 10 7	23590	7	.	WHS
Uskub	42 01 2 N	21 26	Jul 17, 11	9 2, 11.0 ...	5 09 2 W	14 1	56 48 4 N	9 7, 10 6	.23948	7	202.125	WHS
Drama .	41 09 0 N	24 11	Jul 28, 11	10.2, 11 8, 13 2	4 17.1 W	15 2 ..	55 39 3 N	10 6, 11 4	.24618	7	202.12	WHS
Rumeli Hissar.	41 05 3 N	29 05	Jun 22, 11	9.7, 11 5 .	2 01 0 W	14 9 .	55 10 4 N	10 2, 11.1	24998	7	202 125	WHS
Monastir .	41 00 5 N	21 21	Jul 23, 11	9.6, 9 9, 11.6	5 15 4 W	14 9 . .	55 43 1 N	10 4, 11 2	24426	7	202.125	WHS
Dede-Agach	40 50 1 N	25 55	Jul 29, 11	13.9, 15 7 .	3 39 2 W	18 6 . ..	55 14 4 N	14.4, 15 3	.24768	7	202 12	WHS
Salonica	40 38.8 N	22 55	Jul 21, 11	9.4, 11.4 ..	4 47.2 W	14.6 .	55 23.4 N	10.0, 11 0	24560	7	202 125	WHS

NORTH AMERICA.

CANADA.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Fort Severn	55 59 4 N	272 20	Jul 19,'13	15 2, 17 2	4 32.3 W	14 0	83 31 4 N	15 8, 16 8	.07176	16	222 12356	E&W
			Jul 19, 13	12 8, 15.0	4 38.8 W	...	...	14.0	*07150*	*222*	...	E&W
			Jul 20, 13	8.8	4 26.3 W	...	...	...	...	16	...	E&W
			Jul 20, 13	8 9 to 17 9(dv)	4 21.9 W	...	...	...	...	16	...	E&W
			Jul 22, 13	13 0	4 39 3 W	...	...	...	...	16	...	E&W
			Jul 22, 13	13 2 to 20 0(dv)	4 31 4 W	...	...	...	...	16	...	E&W
			Jul 22, 13	20 4	4 29 1 W	...	...	...	...	16	...	E&W
Signal Ridge	55 27 8 N	274 24	Jul 30, 13	12.9, 14 2	10 42 2 W	...	...	13 3, 13 9	07914	16	...	E&W
			Jul 30, 13	15 1, 19 5	10 31 3 W	...	...	17.6	*.07910*	*222*		E&W
			Jul 31, 13	...	...	17 6	82 46 4 N	...	...	...	222.12356	E&W
Fawn-Severn	55 20.8 N	271 51	Jul 16, 13	16 6, 18 0	2 16.9 W	...	...	17 0, 17.7	07942	16	...	E&W
			Jul 16, 13	13 7, 16 2	2 21 4 W	15 1	82 48.7 N	15 2	*.07906*	*222*	222 12356	E&W
Winisk	55 15 6 N	274 44	Aug 1, 13	9 3, 10 8	10 19 7 W	14 8	83 01.1 N	9 7, 10 5	.07640	16	222.12356	E&W
			Aug 1, 13	11 5, 16 5	10 28 5 W	...	...	14 8	*.07651*	*222*	...	E&W
Trout Harbor Island	55 15.4 N	276 13	Aug 6, 13	11 2, 13 7	14 17.9 W	15.0	82 43 4 N	11.5, 12 8	.07957	16	222 12356	E&W
			Aug 6, 13	14 1, 16.6	14 11 6 W	...	...	15 0	*07974*	*222*	...	E&W
Cape Henrietta Maria Isd	54 55 1 N	277 42	Aug 12, 13	7.9, 9.4	14 18.5 W	14 9	82 27.8 N	8 2, 9.0	08188	16	222 12356	E&W
			Aug 12, 13	10 2, 13 2, 16.6	14 20.1 W	...	...	14 8	*08218*	*222*	...	E&W
Pettikau	54 53.1 N	272 25	Jul 14, 13	18 6, 20 4	4 45.6 W	...	...	19 0, 20 0	.08207	16	...	E&W
			Jul 15, 13	9 8, 10 8	4 54.6 W	10 9	82 34 5 N	10 9	*08182*	*222*	222 12356	E&W
Small Otter River	54 15 2 N	270 04	Jul 12, 13	12 8, 14 9	0 15.6 W	17.3	81 58.0 N	13 6, 14.5	.08866	16	222.12356	E&W
			Jul 12, 13	15 9, 19.2	0 17 5 W	...	...	17.5	*08883*	*222*	...	E&W
Opinnagau	54 12 0 N	277 28	Aug 16, 13	10.4, 11 7	13 46.6 W	13.6	82 05.9 N	10 8, 11 4	.08610	16	222.12356	E&W
			Aug 16, 13	12 8, 14.4	13 47 0 W	...	...	13.6	*.08600*	*222*	...	E&W
Trout Lake	53 49.4 N	270 04	Jul 9, 13	16.9, 18 4	1 09.8 E	19 7	81 22.4 N	17.3, 18 0	09431	16	222 12356	E&W
			Jul 9, 13	19 0, 20.4	1 09.4 E	...	...	19 7	*09343*	*222*	...	E&W
Naytahunga	53 48.8 N	277 48	Aug 18, 13	13 4, 15.8	12 36.4 W	10.6	81 50.7 N	13.7, 14.9	08924	16	222 12356	E&W
			Aug 18, 13	9.8, 10.4	12 42.0 W	...	...	10 6	*.08877*	*222*	...	E&W
Jekenakoshis	53 26.8 N	277 45	Aug 20, 13	10 2, 14.3	12 48.8 W	16.9	81 51 7 N	11 0, 12 9	08852	16	222 12356	E&W
			Aug 20, 13	15 3, 18 1	12 45.0 W	...	...	17.0	*08869*	*222*	...	E&W
			Aug 21, 13	8 7	12 34.8 W	...	...	...	...	16	...	E&W
			Aug 21, 13	8.8 to 17.5(dv)	12 48 5 W	...	...	...	...	16	...	E&W
			Aug 21, 13	17.6	12 43.4 W	...	...	...		16	...	E&W
Pakayapon	53 24 9 N	269 28	Jul 7, 13	7.9, 9.4	1 38.4 W	10 6	81 37.4 N	8 3, 9 0	09324	16	222.12356	E&W
			Jul 7, 13	9.8, 11.5	1 41.8 W	...	...	10 6	*09264*	*222*	...	E&W
Attawapiskat	52 55 3 N	277 30	Aug 27, 13	12.8, 14.6	11 49.9 W	16.0	81 07.7 N	13 1, 14 3	09710	16	222 12356	E&W
			Aug 27, 13	15.1, 16.8	11 41 6 W	...	...	16 0	*.09670*	*222*	...	E&W
			Aug 28, 13	7.0	11 33.4 W	...	...	...	...	16	...	E&W
			Aug 28, 13	7.3 to 11.4(dv)	11 37.9 W	...	...	...	...	16	...	E&W
Kakapeshe Lake	52 48.2 N	268 36	Jul 1, 13	11.5, 13 2	3 28 0 E	15 5	80 52 9 N	12.1, 13 0	.10060	16	222.12356	E&W
			Jul 1, 13	14.0, 17 0	3 33 4 E	...	...	15 5	*10065*	*222*	...	E&W
Pakhoan Lake	52 19 2 N	267 52	Jun 25, 13	14.2, 15.7	5 14 1 E	...	...	14.6, 15 4	.10436	16	...	HME
			Jun 26, 13	14.8, 16 5	5 17.8 E	15.7	80 33.0 N	15.7	*.10393*	*222*	222 12356	HME
Fort Albany	52 14.1 N	278 21	Sep 1, 13	10 8, 12 6	11 33 0 W	15 5	80 29.7 N	11 2, 11.8	.10356	16	222.12356	E&W
			Sep 1, 13	14 0, 16.6	11 23 5 W	...	...	15 5	*.10351*	*222*	...	E&W
Fishing Creek	51 54 2 N	277 08	Sep 8, 13	13 3, 15.2	9 46 4 W	17.2	80 35 1 N	14 2, 14 8	10276	16	222 12356	E&W
			Sep 8, 13	16.3, 17.9	9 42 2 W	...	...	17 2	*.10062*	*222*		E&W
White Hill View	51 50.1 N	268 01	Jun 19, 13	17 6, 18 9	4 13 2 E	14 7	79 45 0 N	18 0, 18 6	11374	16	222 12356	HME
			Jun 19, 13	13 5, 15 9	4 02 3 E	...	...	14 6	*11338*	*222*	...	HME
Birch Lake	51 49 7 N	267 40	Jun 18, 13	13 3, 14 8	5 44.0 E	10.6	80 16 1 N	13 8, 14 5	.10792	16	222.12356	HME
			Jun 18, 13	...	...	...	...	10 6	*.10711*	*222*	...	HME
Cat Lake	51 42 6 N	268 07	Jun 16, 13	7 6, 10.2	3 27.8 E	12 5	80 18 1 N	9.1, 9 8	10718	16	222 356	E&W
			Jun 16, 13	10 8, 13 6	3 15 4 E	...	...	12 6	*.10662*	*222*	...	E&W
Long Reach Bend	51 39.0 N	274 38	Sep 16, 13	13 4, 14 6	3 51.4 W	16 7	80 35 3 N	13 7, 14 3	10317	16	222 12356	E&W
			Sep 16, 13	15 6	3 45.4 W	...	...	16.8	*10236*	*222*	...	E&W
Fort Hope	51 34 2 N	272 02	Sep 25, 13	16 1, 17 3	3 50 2 W	...	...	16 4, 17 0	.09586	16	...	E&W
			Sep 26, 13	9 5, 12.4	3 54.0 W	11.0	81 14 2 N	11 0	*.09586*	*222*	222 12356	E&W
Martin's Falls	51 32.5 N	273 44	Sep 19, 13	16 2, 17 3	3 12 6 W	...	...	16.5, 17 0	.10606	16	...	E&W
			Sep 20, 13	10 3, 12.3	3 13 7 W	11 4	80 22 4 N	11.4	*.10500*	*222*	222.12356	E&W
Ochichoo Chooena	51 29 6 N	268 02	Jun 14, 13	13.9, 15.7	4 19 5 E	11 0	79 52.0 N	14.4, 15 1	11272	16	222 12356	E&W
			Jun 14, 13	10.1, 13.1	4 27.2 E	...	...	11.1	*.11207*	*222*	...	E&W
Greenwood Rapids	51 29 2 N	271 03	Sep 29, 13	14.6, 17.4	0 48 6 W	...	...	15 8	*.11071*	*222*	...	DMW
			Sep 30, 13	7.7, 11 0	0 47 8 W	15 8	79 53 0 N	8.4, 10 3	11112	16	222 12356	DMW
Chipie River	51 28.8 N	276 36	Sep 10, 13	16.4, 17.5	8 35 5 W	...	...	16.6, 17 3	.10679	16	...	E&W
			Sep 11, 13	6.5, 9.2	8 31.3 W	8.1	80 15.3 N	8 1	*10576*	*222*	222 12356	E&W
Fawcett's Post	51 11.4 N	269 47	Jun 5, 13	10.5, 13 4	3 55 0 E	15.0	80 06 2 N	11 1, 12.0	.10914	16	222 12356	HME
			Jun 5, 13	13.9, 16 2	3 52 6 E	...	...	15 0	*.10906*	*222*	...	HME
			Jun 7, 13	15.5	3 53.4 E	...	...	...	...	16	...	HME
			Jun 7, 13	15.6 to 16.6(dv)	3 55.4 E	...	...	...	...	16	...	HME
			Jun 7, 13	16.7	3 57.9 E	...	...	...	...	16	...	HME
Slate Falls	51 09.6 N	268 21	Jun 12, 13	10.7, 13.7	4 39.4 E	9.2	79 55 2 N	11 2, 13 3	.11130	16	222.1235	E&W
			Jun 12, 13	7.1, 10.3	4 49 2 E	...	...	9.2	*.11098*	*222*	...	E&W

NORTH AMERICA.

CANADA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L M T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Osnaburgh House	51 08 2 N	269 44	Jun 8,'13	8 6 . .	2 57 7 E	. . .	.... .		..	16	. .	E&W
			Jun 8, 13	8 9 to 11 6(dv)	2 52 0 E	. .				16	. .	E&W
			Jun 8, 13	11 6, 12 3 .	2 46 2 E		.... .	.	.	16	. .	E&W
			Jun 8, 13	12 4 to 16 0(dv)	2 44 1 E	.	.. .	. .	.	16	. . .	E&W
			Jun 8, 13	16 0 . .	2 46 2 E	. ..	. .			16	.	E&W
The Forks . . .	51 06 0 N	275 28	Sep 13, 13	13 3, 14 5	6 17 4 W	16 0 .	79 55.4 N	13 6, 14 2	11065	16	222 12356	E&W
			Sep 13, 13	15 1	6 14 0 W	. .	. ..	16 0 .	*.11023*	*222*		E&W
Lake St Joseph. . . .	51 04 0 N	269 10	Jun 2, 13	16 3, 17 6 .	4 52 4 E	14 5 .	80 06.5 N	16 7, 17 3	10923	16	222 12356	HME
			Jun 2, 13	13 3, 15 6 .	4 53 8 E		. .	14 4 ..	*10890*	*222*	.	HME
Pigeon Portage	50 51 0 N	268 32	Jun 1, 13	9 3, 10 8 . . .	5 32 5 E	6.6 .	79 35 0 N	9 7, 10.4	.11531	16	222 12356	HME
			Jun 1, 13	5 6, 7 6 .	5 41.2 E	. .	. ...	6 7 .	*11498*	*222*	. . ..	HME
Mouth of Root River ...	50 40.4 N	268 17	May 30, 13	15 2, 16 6 .	4 57.4 E	14.0 . .	79 19.6 N	15 6, 16.2	11840	16	222.12356	HME
			May 30, 13	13 0, 14 9 . .	4 55.6 E	...	.	14.0	*.11776*	*222*	. .	HME
Lac Seul... ...	50 19.3 N	267 43	May 26, 13	15 1, 17 1	5 27 3 E	.... ..	. ..	15 6, 16 7	11720	16	. . .	E&W
			May 27, 13	10 2, 13 8	5 24.6 E	11 3 . .	79 24 6 N	11 4 .	*11645*	*222*	222 12356	E&W
			Oct 11, 13		.	14 6 .	79 23 8 N	15 8, 16 3	.11696	16	222.12356	HME
			Oct 11, 13	. .	.		.	14 6 . .	*.11661*	*222*	. . . .	HME
			Oct 12, 13	15 2, 15 7 .	5 25 6 E		.	..		16	. . . .	HME
Fort William . .	48 23 3 N	270 44	Oct 16, 13	13 0, 15 3	2 56 2 E	14 3 ..	77 50 6 N	14 3 .	*13263*	*222*	222.12356	DMW
			Oct 17, 13	8 6, 11 4, 16 1	3 05.8 E	.	...	9.2, 10.2	.13224	16	.	DMW
Ottawa .	45 23 6 N	284 17	Oct 21, 13	12 2, 15 0, 16 1	13 15.5 W	. .	. . .	15 3, 15 8	.15037	16	..	E&W
			Oct 21, 13		... .	....	. .	16 4, 16 9	15043	16	. . . .	E&W
			Oct 22, 13	9 4, 10 6 .	13 15.6 W	15.8 .	75 40.2 N	9.7, 10 3	.15008	16	222 1256	E&W
			Oct 23, 13	. . . .	. .	9 8, 12 0	75 42 0 N	15 8	*15062*	*222*	222 1256	E&W
			Oct 23, 13	. ...	. .. .	13.5 .	75 41 2 N	. . .			222.1256	E&W
			Oct 23, 13	. . . .	... .	15 8	75 39 8 N	. .	.		222 12356	E&W

CENTRAL AMERICA.

Station	Latitude	Long East of Gr	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Colon Harbor . .	9 21.4 N	280 03	Apr 4,'12	12 9, 14 3 .	4 52 8 E	15.2 ...	35 16 6 N	13 3, 14 0	32372	14	14 12	JPA
Colon Harbor, *B* ..	9 21 2 N	280 03	Oct 25, 12	11.4, 13 2 .	4 51 4 E	16.1 . .	35 23 6 N	11 9, 12 8	32384	16	177 1256	ADP

UNITED STATES.

Station	Latitude	Long East of Gr	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Greenport, *A*	41 06 4 N	287 38	Dec 17,'13	14.2, 15 3	11 21.9 W	12.5, 12.8	72 11 4 N	14 6, 15.0	18113	4	EI 2	C II
			Dec 17, 13	. . . .	......	13.0, 13 4	72 11 2 N	. . .	.... .	.	EI 2	C II
			Dec 18, 13	9 3, 10 4 .	11 17.9 W	11 2, 11.4	72 11 6 N	9 6, 10 1	18098	4	EI 2	C II
			Dec 18, 13	.. . . .	. . . . .	11.6, 11 8	72 11 4 N	. . . .	.. . ...	.	EI 2	C II
Derring Harbor	41 05 N	287 39	Dec 17, 13	14 3, 16 2 . .	11 38 2 W	12 3 ...	72 18 8 N	14 8, 15 8	18015	2	201 12	C II
			Dec 18, 13	9 6, 11 6 ..	11 39 0 W	12 2 . .	72 17 3 N	10 2, 11 2	17994	2	201 12	C II
Baltimore, Homewood, *A*	39 19 9 N	283 23	Apr 16, 12	12 3, 14 2 ..	6 15 4 W	. ....	.... ..	12 9, 13 9	.19077	10	. . . .	F&G
			Apr 17, 12	15 3, 17 6 . . .	6 11 5 W	9.6 . . .	71 16.5 N	15 4, 17.1	.19084	10	222.1256	F&G
Baltimore, Homewood, *B* .	39 19 9 N	283 23	Apr 16, 12	... ...	. ...	16.9 . . .	71 13.0 N	... .	. ...	. . .	222 1	F&G
			Apr 17, 12	11 5, 13.2 ..	6 14 2 W	16 9 . . .	71 16 3 N	12.0, 12.8	.19085	10	222 2	F&G
			Apr 18, 12	. . ... .	. . .	16 9	71 13 3 N	. ...	. ...	.. ...	222 5	F&G
			Apr 19, 12	. . ... .	....	16.9	71 16 3 N	... ..	. .. .	. .	222 6	F&G
Washington, New Site . .	38 57 5 N	282 56	Oct 8, 12	. ...	... .	16.0	70 52 9 N	... ..	... ..	.... .	222.1256	CCC
			Oct 9, 12	10 7, 12 7 ..	4 26 9 W	....	. ...	11.5, 12 3	.19256	10	.	CCC
			Oct 10, 12	6 3, 11.0	4 26.0 W	... . .	. ... ..	. . .	. . . .	10	..	CCC
			Oct 10, 12	6 4 to 10 9(dv)	4 23 7 W	... .	. . .. ..	. . . .	. . . .	10	. .	CCC
Washington, Coleman Park, *A*	38 56 2 N	282 57	Aug 20, 12	. . . .	....	16 4	71 31 1 N	. . . .	. . .	.	19.12	HWF
			Aug 21, 12	10 3, 13 5 . .	2 57.4 W	....	....	10 8, 11 4	19119	19	...	HWF
Washington, Coleman Park, *X*	38 56 2 N	282 57	Aug 19, 12	11 4	2 53 2 W	....	.. ... .	12 4, 13 5	19326	19	... . ..	HWF
			Aug 21, 12	. ..	....	16 7 ...	71 12.2 N	.. . .	. .. .	.	19 1	HWF
Cheltenham, *B₁*	38 44 0 N	283 10	Nov 18, 13	11 6, 15 4, 15 7	5 57.4 W	. ... ..	. .	13 7, 14 8	19575	3	.. ... .	HME
			Nov 19, 13	11.5, 11 8 .	5 57 7 W	. ...	. . .	7 8, 8 6	.19564	3	.. ..	HME
			Nov 19, 13	14 8, 15 0	5 58.0 W	. ..	. ... .	13 3, 14 0	.19568	3	....	HME
			Nov 20, 13	8 8, 9 1	5 55.0 W	10.2, 10.8	70 43 0 N	7 6, 8 4	.19568	3	EI 48	HME
			Nov 20, 13	11 3, 11 6 . . .	5 58 2 W	16 4 . .	70 42 1 N	14 8, 15 5	19580	3	EI 48	HME
			Nov 21, 13	11.5, 11 7 . . .	5 58 8 W	10.3, 10 8	70 42 7 N	7 6, 8 5	19574	3	EI 48	HME
			Nov 21, 13	14 9, 15.1 .	5 57.8 W	15 7, 16 4	70 42 2 N	13 6, 14 5	19574	3	EI 48	HME
			Nov 22, 13	8 6, 8 8 .	5 53 8 W	9.6, 10 2	70 43 4 N	7 5, 8 2	19570	3	EI 48	HME
			Nov 22, 13	11.3, 11 5	5 58 3 W	10 8, 15 2	70 43 1 N	13 5, 14 4	19562	3	EI 48	HME
			Nov 22, 13	. ... . .	.... .	15.7, 16.4	70 42 4 N				EI 48	HME
			Nov 23, 13	9 0, 9.2 .	5 54.4 W	.	. . .	7 8, 8 6	.19568	3	....	HME
			Nov 23, 13	11 0, 11 2 . .	5 57.5 W	. . . . .	.. .	13 5, 14 4	.19579	3	. ...	HME

SOUTH AMERICA.

ARGENTINA.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Puerto Aguirre	25 35 7 S	305 23	Sep 24,'13	16.7, 17.0	0 27.9 W	...	...	...	...	19	.	HFJ
			Sep 28, 13	9.3, 10 7	0 31.0 W	13.1 ...	15 22.2 S	9 8, 10 4	25456	19	19 256	HFJ
			Sep 30, 13	9.2 . ..	0 31.4 W	10.0 .	15 21 6 S	.		19	19 12	HFJ
Formosa	26 10.7 S	301 49	Nov 3, 13	10 1, 11 3	2 50.2 E	13 4 ..	17 10 3 S	10.4, 11 0	25304	19	19 1256	HFJ
Piray	26 28.8 S	305 15	Oct 2, 13	9.9, 11 2, 15.8	0 16.5 W	14 7 ...	18 14 3 S	10.3, 11 0	24997	19	19 256	HFJ
Itati	27 16 0 S	301 46	Oct 23, 13	10 0, 11 0	3 09 4 E	8 6 .	18 39 8 S	10.2, 10 7	.25153	19	19 1256	HFJ
Posadas	27 21 7 S	304 04	Sep 12, 13	9 8, 11 0 .	1 43.2 E	13 1, 15.1	18 37 5 S	10 1, 10.7	.25006	19	19 126	HFJ
Ita-Ybate	27 25.6 S	302 40	Oct 18, 13	10 0, 11 0	2 29 1 E	14.4 ...	18 28 7 S	10 2, 10 7	25134	19	19 1256	HFJ
Corrientes	27 28 7 S	301 10	Oct 27, 13	10 0, 11.3	3 51.4 E	13 5 . .	18 50 6 S	10.4, 11 0	.25209	19	19.126	HFJ
Ituzaingo	27 35 1 S	303 18	Oct 16, 13	9 8, 10 8	1 45 0 E	13 8	19 15.5 S	10 1, 10 6	.24923	19	19 1256	HFJ
Saladas	28 15 6 S	301 21	Aug 21, 13	9.4, 11 1	3 52.4 E	14 1 ..	19 56 7 S	10 2, 10 8	.25173	19	19 126	HFJ
Mercedes	29 09 9 S	301 53	Aug 19, 13	14 4 . .	3 25.8 E	15 6 .	21 03.0 S			19	19 2	HFJ
			Aug 20, 13	10 2, 11 3	3 24.2 E	9 3 .	21 05 0 S	10 5, 11 0	25060	19	19 256	HFJ
Monte Caseros	30 15.4 S	302 22	Aug 16, 13	9.8, 11.1	3 26.9 E	13.8 ...	22 36 4 S	10 2, 10.8	25074	19	19 126	HFJ
Concordia	31 24 9 S	302 05	Aug 5, 13	15.7 .. .	4 22 6 E	14.4	24 25 3 S	.	.	19	19.1256	HFJ
			Aug 6, 13	8 2, 11.0 .	4 21 0 E	9 1 ..	24 26 2 S	10 1, 10 8	.24905	19	19 12	HFJ
Pilar, Pier *1*	31 40 1 S	296 07	Jun 21, 13	8 9, 10 7 . .	8 47 4 E	...	...	9 5, 10 3	.25636	19	..	HFJ
			Jun 21, 13	11.2, 11 6, 11 9	8 47 9 E	...	...	13 8, 14 6	.25626	19	...	HFJ
			Jun 21, 13	15.1, 16 6 ...	8 48 8 E	..	.	15 5, 16 3	25635	19		HFJ
			Jan 30, 11	9 2, 11 3 .	9 09.4 E	. .		10 8, 15 1	25702	2		C II
			Jan 30, 11	14 6, 16.6 .	9 13.2 E		..	16 0 .	25693	2	...	C II
			Jan 31, 11	9.0, 11 2 ..	9 09 6 E	.	. .	9 7, 10 7	25703	4		C II
			Jan 31, 11	14.4, 17 6 . .	9 10.1 E	...		16 2, 17 1	25658	4	.	C II
Pilar, Pier *8*	31 40.1 S	296 07	Jun 24, 13	...	.	15 0	25 46 6 S	...	...		19 126	HFJ
			Jan 23, 11	...	...	15.1, 16.6	25 49 6 S	...	.	.	201 12	C II
			Jan 24, 11	...	...	9 7 .	25 49 0 S	. .	.	.	201.12	C II
			Feb 2, 11	...	. .	9 6, 10 9	25 50 9 S	.	...	...	201.12	C II
			Feb 2, 11	...	...	12.0 ..	25 50 1 S	...	. .	..	201 12	C II
			Feb 2, 11	...	...	16 0, 17 0	25 51.6 S	.			EI 2	C II
			Feb 2, 11	...	...	17.6 ..	25 51.8 S	. .		.	EI 2	C II
Pilar, *B*	31 40 1 S	296 07	Jun 23, 13	8.8, 10.5, 11.0	8 47.1 E	...	..	9 3, 10 0	.25614	19	...	HFJ
			Jun 23, 13	14.4, 14.9, 16.6	8 48.0 E	...	.	11 4, 14 0	25606	19	..	HFJ
			Jun 23, 13	...	...	...		15 4, 16 2	25610	19	...	HFJ
			Jun 24, 13	...	...	10.4 .	25 46 5 S	. .		..	19 126	HFJ
			Jan 28, 11	9 9, 12 1	9 10.3 E	...	...	10.4, 11.4	.25644	4	.	C II
			Jan 28, 11	14 4, 16.4	9 09.7 E	...	...	15 0, 16 0	25662	4	.	C II
			Jan 31, 11	9 0, 11 2 . .	9 08.6 E	...	...	9.7, 10.6	.25694	2	...	C II
			Jan 31, 11	14.4, 17 6	9 09 6 E	...	...	16.3, 17 2	25651	2	...	C II
			Feb 1, 11	...	.	13.9, 14 5	25 52.3 S	.. .	. .	. .	EI 2	C II
			Feb 1, 11	...	...	15.1, 16 2	25 54 0 S	.. ..	...		EI 2	C II
			Feb 2, 11	...	.. .	15 8, 17.0	25 55 1 S		.	.	201.12	C II
			Feb 2, 11	...	.	17.6 ...	25 55.3 S		...	. .	201 12	C II
Pilar, *C*	31 40 1 S	296 07	Jun 19, 13	15.1, 15 4 .	8 47 1 E	. .	.	..		19	. ..	HFJ
			Jun 20, 13	9 4, 11.5 ..	8 46 4 E	...	...	10 1, 11.0	.25612	19	.	HFJ
			Jun 20, 13	11.8, 12 1 ..	8 47.2 E		...	14 0, 14 8	.25607	19	. .	HFJ
			Jun 20, 13	...	. .	.. ..	...	15.5, 16 2	.25604	19	.. .	HFJ
			Jan 28, 11	9 9, 12.1	9 10.0 E	...	...	10 4, 11 3	.25658	2		C II
			Jan 28, 11	14 3, 16 4 .	9 09 2 E	.. ..	.	14.9, 15 9	.25670	2	.	C II
			Jan 30, 11	9.2, 11 3	9 07 8 E	.	...	9 8, 10 8	.25664	4	.. .	C II
			Jan 30, 11	14 6, 16.6 .	9 11 2 E	...	...	15 1, 16 0	.25636	4	.	C II
			Feb 1, 11	...	. .	14 1, 15.0	25 52 6 S	. .	..		201 12	C II
			Feb 1, 11	...	...	16.2 .	25 54.0 S	.. .	...	.	201 12	C II
			Feb 2, 11	...	...	9.5, 11.0	25 53 1 S	. .	...	...	EI 2	C II
			Feb 2, 11	...	. .	12 0 ...	25 53 1 S	.. .	. .	. .	EI 2	C II
Victoria, *1911*	34 27.3 S	301 27	Feb 11, 11	16 4, 16 6 . .	6 02 8 E	...		...	. .	4	.. .	C II
Victoria, *1913*	34 27.3 S	301 27	Jun 27, 13	11 0, 12 1 . .	5 41 3 E	14 4 . .	27 47 9 S	11 3, 11 9	.24922	19	19.1256	HFJ

BOLIVIA.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor Intensity: L. M. T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Guayara Mirim	10 48 0 S	294 37	Jul 8,'11	9 0, 10 0 . .	4 21.2 E	11.0 .	5 44 8 N	9.3, 9 7	.28375	13	177 1256	CCS
La Paz	16 30 8 S	291 49	Jun 19, 12	9 6, 11 0, 14 9	7 12 0 E	13.2 ..	5 07 6 S	10 0, 10 7	.27899	14	14 1256	JPA
			Jul 11, 12	7 4 to 17.9(dv)	7 10 6 E	.. ..	. .			.14		JPA
			Dec 6, 12	. . .	..	.		11 0, 11 5	27924	14		HRS
			Dec 7, 12	12 4, 12 7 ..	7 06 2 E	10.4, 14 5	5 09 6 S			14	14.1256	HRS
			Dec 7, 12	16 1, 16 4	7 05 9 E					14	.	HRS

SOUTH AMERICA.

BOLIVIA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	γ			
Guaqui	16 36 1 S	291 04	Dec 3,'12	13 2, 15 0	7 29 8 E			13 7, 14 6	28016	14		HRS
			Dec 4, 12			9 7	5 45 8 S				14 1256	HRS
Patacamaya	17 15 3 S	292 05	Jul 8, 12	16 6	7 15 1 E	15 3	6 26 5 S			14	14 1256	JPA
			Jul 9, 12	9.3, 10 4	7 15.4 E			9 6, 10 1	27734	14		JPA
Huarnonia	17 49 2 S	293 21	Jul 4, 12	9.5, 10.7	6 38 8 E	13 3	6 35 2 S	9 9, 10 4	27516	14	14 1256	JPA
Oruro	17 59 3 S	292 56	May 22, 12	13.9, 15 3	7 02 1 E	12 2	7 16.6 S	14 3, 14 9	27660	16	177 1256	DM
Challapata	18 55 5 S	293 09	Jun 24, 12	9 8, 11 0	7 03 0 E	13 1	8 41.1 S	10 1, 10 7	27309	14	14 1256	JPA
Potosi	19 36 1 S	294 10	Jun 28, 12	9 8, 11 1	6 40 4 E	13 0	9 22 8 S	10 1, 10 8	27084	14	14 1256	JPA
Rio Mulato	19 43 1 S	293 10	Jun 26, 12	9 8, 11 0	7 15 8 E	13 2	10 01 0 S	10 1, 10 7	27159	14	14 1256	JPA
Uyuni	20 28 1 S	293 09	May 18, 12	10 7	7 30 7 E	13 9	11 08 5 S	11 2	.27048	16	177 5	DM
			Jun 23, 12	9 6, 11 0	7 28 6 E	13 2	11 10 3 S	10 0, 10 6	.27038	14	14 1256	JPA

BRAZIL

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	°	h h	° ′	h h	γ			
Fazenda "Porre"	3 09 9 N	299 39	Nov 1,'13	12.9, 14 8	1 50 4 W	10 6, 11 0	30 19 9 N	13 6, 14 4	.30090	21	21 (343)4)	ADP
Boa Vista	2 49 N	299 19	Oct 28, 13	9 8, 11 6	1 29 4 W	14 8, 15 1	29 12.2 N	10 4, 11 2	.29991	21	21 (343)4)	ADP
Campiña	2 28 1 N	299 10	Oct 23, 13	8 5, 11 0	0 37 6 W	13.8	30 02.5 N	9 9, 10 7	.30094	21	21.(343)4)	ADP
Caracarahy	1 48 7 N	298 52	Oct 6, 13	13 1, 15 2	0 41 0 W	17.1	27 59.7 N	13 8, 14 8	.30235	21	21.(343)4)	ADP
Alliança	1 27 4 N	298 43	Oct 7, 13	12.8, 14.6	0 58 2 W	15 8	27 33.3 N	13 4, 14 1	.30195	21	21.(34)	ADP
Cucuhy	1 11.4 N	293 10	Jul 27, 13	10 9, 13 2	2 13.8 E	16 5, 16 8	25 58.6 N	11 8, 12.8	30626	21	21.(343)4)	ADP
San Marcelino	0 54 8 N	292 44	Jul 30, 13	14 9	2 09.1 E					21		ADP
			Jul 31, 13	9 2, 12.0	2 10 6 E	14 5	25 37.5 N	10.6, 11 5	.30703	21	21 (33)4)	ADP
San Francisco	0 27.7 N	298 13	Oct 15, 13	9 7, 13.8	0 07 2 W	15 8	25 52 3 N	12.4, 13.3	.29946	21	21.(343)4)	ADP
San Felipe	0 22 N	292 37	Aug 2, 13	9 0, 11 6	2 37 5 E	14 9	24 06.8 N	10.3, 11 2	.30806	21	21 (34)4)	ADP
Umarituba	0 20 S	293 24	Aug 4, 13	10 0, 13.5	2 21 7 E	15 6	23 28.4 N	10 6, 11 4	.30560	21	21 (343)4)	ADP
San Joaquim	0 22 6 S	295 57	Aug 8, 13	11 4, 15 8	1 13 4 E	17 2	23 58 4 N	14.7, 15 4	.30075	21	21.(343)4)	ADP
Santa Isabel	0 25 S	294 58	Aug 6, 13	14.2, 16 0	2 10 0 E	17 8	25 09.8 N	14.8, 15 6	29938	21	21.(343)4)	ADP
Sant Anna.	0 31 7 S	296 31	Aug 10, 13	8.7, 11 1	0 58 0 E	15 7	23 51.7 N	9 9, 10 7	.30118	21	21 (343)4)	ADP
Santa Maria	0 35 3 S	298 10	Oct 9, 13	8 2, 10 7	0 03 8 E	13 6	24 10 4 N	9 6, 10 3	30065	21	21 (343)4)	ADP
			Oct 10, 13	8 3, 9.1	0 04 2 E					21		ADP
			Oct 11, 13	8 3	0 05 1 E					21		ADP
			Oct 11, 13	8 4 to 10 4(dv)	0 04 3 E					21		ADP
			Oct 11, 13	11 4 to 17 0(dv)	0 04 4 E					21		ADP
Barcellos	0 58 2 S	297 07	Aug 11, 13	11 2, 14 7	0 40 8 E	16 5	23 29 8 N	13 6, 14 3	29994	21	21 (343)4)	ADP
Menena	1 17 6 S	297 47	Aug 12, 13	13 0, 15 2	0 16 0 E	17 4	22 35.8 N	13 6, 14 6	29914	21	21 (343)4)	ADP
Pinheiro, *A*	1 17 9 S	311 31	May 9, 11	7 8, 17.2, 18 0	8 01 8 W	9.5	23 03 9 N	8 0	29071	13	177 1256	CCS
			May 9, 11					17 4, 17 8	29093	13		CCS
Antonio Lemos	1 21.4 S	309 08	Apr 29, 11	14 5, 15 5	6 06 6 W			14 8, 15 2	29118	13		CCS
			Apr 30, 11			9 0	23 18 6 N				177.1256	CCS
Gurupa	1 22 1 S	308 25	Apr 27, 11	15 2, 16 2	5 39.0 W	14 5	23 16 6 N	15 5, 16.0	.29087	13	177.1256	CCS
Inajatuba	1 34 S	298 28	Aug 13, 13	10 1, 13.6	0 59 8 E	15 3	21 59 2 N	10 7, 11 6	30300	21	21.(343)4)	ADP
Obidos	1 55.8 S	304 33	Apr 10, 11	8 3, 9 3	3 09 6 W	10 2	22 29 6 N	8 6, 9.0	29234	13	177 1256	CCS
Ayrao	1 55 9 S	298 38	Aug 14, 13	10 1, 11 9	0 05 6 W	16 3	21 45 7 N	10 8, 11 6	29742	21	21 (43)4)	ADP
Monte Alegre	2 01 0 S	306 01	Apr 18, 11	7 4, 8 3	4 01 2 W	9.2, 9 6	22 27 2 N	7 7, 8 1	.29143	13	177 1256	CCS
Santarem	2 31 S	305 21	Apr 14, 11	8 2, 9 2	3 37 7 W	10 0	21 52.7 N	8 5, 8 9	29110	13	177 1256	CCS
Parintins	2 36 8 S	303 16	May 22, 11	9 5, 10 6	2 11.6 W	13 9	21 09.9 N	9 8, 10 3	.29284	13	177 1256	CCS
Taupeçaçu	2 37 5 S	299 04	Aug 15, 13	13.0, 15 3	0 40.0 W	17 3	20 05 3 N	13 8, 14 9	29702	21	21.(343)4)	ADP
Urucurituba	2 47 9 S	302 20	Apr 23, 11			17.1	21 06 6 N				177 1256	CCS
			Apr 24, 11	13 9, 14 9	1 34 8 W			14 2, 14 6	29198	13		CCS
Manaos, *II*	3 07 6 S	300 01	Mar 22, 11			8 8	20 13.9 N				177 1256	CCS
			Mar 30, 11	7 0 to 18.0(dv)	0 04 6 W					13		CCS
			Mar 31, 11	17.3	0 03.9 W			17 6, 18 0	.29408	13		CCS
			Sep 17, 13	10 2, 13 0	0 35 2 W	15.3	20 33 6 N	11 1, 12 0	.29562	21	21 (343)4)	ADP
Itacoatiara	3 08 9 S	301 35	Apr 8, 11	7 9, 9.1	0 53.1 W	9.9	20 19.4 N	8 3, 8 8	29368	13	177 1256	CCS
Pernambuco	8 02 8 S	325 08	May 14, 13			17 1	4 05.7 N				201 12	C II
			May 15, 13	7 9, 10 3	17 28 2 W			8 5, 9 8	.27842	4		C II
Porto Velho	8 45 6 S	296 02	Jun 9, 11	8 2, 9 3	3 09 8 E	10.2	9 50 2 N	8 6, 9 0	28974	13	177.1256	CCS
Caracol	9 13 6 S	295 34	Jun 14, 11	7 9, 9.0	3 48 0 E			8 2, 8 8	.28830	13		CCS
			Jun 15, 11			8 2	8 44 6 N				177.1256	CCS
Mutum	9 37 3 S	295 00	Jun 16, 11	7 9, 8 9	3 48 7 E			8 2, 8 7	29036	13		CCS
			Jun 17, 11			8 5	6 34 3 N				177 1256	CCS
Abuná	9 42 0 S	294 31	Jun 19, 11	8 4, 9 4	4 09 6 E			8 6, 9.1	29012	13		CCS
			Jun 21, 11			9.5	7 25 7 N				177.1256	CCS
Camp No 39	10 11 2 S	294 33	Jun 26, 11	7 4, 8 5	4 12 9 E	10 5	6 04.7 N	7.7, 8 2	28930	13	177 1256	CCS

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BRAZIL—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Jaburu, *A*	12 57 2 S	321 24	May 3,'13			10 2 to 14 4(8)	2 21 7 S				EI 2	C II
			May 3, 13			14 7 to 17 1(8)	2 23 5 S				EI 2	C II
			May 4, 13			10 9, 12 2	2 19 9 S				201 12	C II
			May 4, 13			14.7	2 21 4 S				201.12	C II
			May 5, 13	9.7, 9 9, 10 5	14 38 4 W	15 5, 16 6	2 22 0 S			19	201 12	C II
			May 5, 13	10 6, 11.2, 11.5	14 37.3 W					19		C II
			May 6, 13			10.5, 11 8	2 19.3 S				201 12	C II
			May 6, 13			14 2, 15 2	2 21 4 S				201 12	C II
			May 6, 13			16 2, 17 1	2 22 7 S				201.12	C II
			May 7, 13			9 6, 10 4	2 19 8 S				201.12	C II
			May 7, 13			11 1, 13 0	2 19 8 S				201.12	C II
			May 7, 13			13 8, 14 5	2 20 2 S				201 12	C II
			May 7, 13			15 2, 16 0	2 21 6 S				201 12	C II
			May 7, 13			16 7	2 20 2 S				201.12	C II
			May 8, 13	10 8, 12 7, 13 8	14 37.4 W					14		C II
			May 8, 13	15.2, 15 7, 15 8	14 37.2 W					14		C II
Jaburu, *B*	12 57 2 S	321 24	May 1, 13	9.7, 12 5, 13.5	14 37 2 W			10 4, 12 0	.26535	19		C II
			May 1, 13	16.2	14 37 0 W			14.1, 15 5	.26478	19		C II
			May 3, 13			10 7, 11 9	2 19.6 S				201 12	C II
			May 3, 13			12 9, 14 6	2 20 7 S				201 12	C II
			May 3, 13			15 8, 16 8	2 22 6 S				201.12	C II
			May 4, 13			10.8 to 15 2(9)	2 21 3 S				EI 2	C II
			May 5, 13	9.7, 9 9, 10 5	14 39 7 W					14		C II
			May 5, 13	10.6, 11.2, 11 6	14 38 0 W					14		C II
			May 7, 13			10.3, 13.6	2 21 6 S				19.1256	C II
			May 7, 13			16 3	2 21 9 S				19 1256	C II
			May 8, 13	10.8, 12.7, 13.8	14 37.9 W			11 4, 12 3	.26485	19		C II
			May 8, 13	15 2, 15 6, 15.8	14 37.6 W			14 2, 14 8	26445	19		C II
			May 8, 13	16 4, 17 1	14 37 5 W					19		C II
			May 10, 13	10.6, 11 8, 13 0	14 37.4 W			10.9, 11 5	.26518	4		C II
			May 10, 13	14.3, 14.7, 16.0	14 40 1 W			13 3, 14.0	.26488	4		C II
			May 10, 13					15 0, 15 6	26450	4		C II
			May 10, 13					9.4, 10 0	.26463	19		C II
			May 12, 13			10.9	2 21 0 S				19 1256	C II
Jaburu, *C*	12 57.2 S	321 24	Apr 29, 13	14 9	14 39 3 W					19		C II
			Apr 30, 13	10.0, 12 1	14 35 8 W			10 5, 11 6	.26513	19		C II
			Apr 30, 13	13 2, 15 2	14 36 7 W			13.6, 14 7	26488	19		C II
			May 4, 13	16.4	14 39 7 W					19		C II
			May 5, 13			16 5, 16 8	2 25 6 S				19.12	C II
			May 6, 13			11 5, 14 8	2 19.4 S				19.1256	C II
			May 6, 13			16 7	2 23 0 S				19.56	C II
			May 7, 13			10 2	2 20 8 S				14 1256	C II
			May 7, 13			13 8, 16 3	2 22 2 S				14 1256	C II
			May 8, 13	10 8, 12.7, 13 8	14 37 5 W			11.4, 12 2	.26484	4		C II
			May 8, 13	15 2, 15.7, 15.8	14 37 0 W			14 2, 14 8	.26460	4		C II
			May 10, 13	10 5, 11.8, 13 0	14 37 3 W			10 9, 11.5	.26488	19		C II
			May 10, 13	14 3, 14.7, 16 0	14 40 0 W			13 3, 14 0	26479	19		C II
			May 10, 13					15 0, 15 6	26438	19		C II
			May 10, 13					9 4, 10 0	26501	4		C II
			May 12, 13			10.9	2 21 6 S				14 1256	C II
Corumbá, *A*	18 59 4 S	302 21	Dec 12, 13	10 0, 11 0	0 33 9 E	13.6	6 23 4 S	10 3, 10 8	26362	19	19 1256	HFJ
Corumbá, *B*	19 00 1 S	302 21	Dec 10, 13	10 1, 11 3	0 33 4 E	16 1	6 23 6 S	10 5, 11 1	26346	19	19 1256	HFJ
Porto Esperança	19 36 8 S	302 32	Nov 29, 13	10 2, 11 4	0 31 1 E	14.4	6 43 2 S	10 6, 11 2	26256	19	19 1256	HFJ
Barranco Branco	21 05 3 S	302 10	Nov 24, 13	9 7, 10 9	1 07 3 E			10 0, 10 6	25996	19		HFJ
			Nov 26, 13	8 6	1 06 8 E	9 6	9 32.1 S			19	19 1256	HFJ
Murtinho	21 41 8 S	302 07	Nov 20, 13	14 8, 15 9	1 19 4 E	13 8	10 31.2 S	15 1, 15 6	.25936	19	19 1256	HFJ
Vassouras, *A*	22 24 0 S	316 21	May 21, 13	13 7	10 05 2 W			14 8, 16 6	.24617	19		HFJ
			May 22, 13	9 0, 10.3, 14 9	10 06 6 W			11 4, 14 0	24647	19		HFJ
			May 23, 13	9 1, 13 3	10 06 3 W			10 2, 11 2	24657	19		HFJ
			May 25, 13	11 2	10 05 2 W	14 3, 16 4	14 29 6 S			19	19 2	HFJ
			May 26, 13			8 9	14 30 1 S				19 2	HFJ
Vassouras, *B*	22 24 0 S	316 21	May 23, 13	14 4	10 03 6 W			15 3, 16 6	24631	19		HFJ
			May 24, 13	10 1, 10 7	10 02 1 W			11 5, 13 3	24650	19		HFJ
			May 24, 13	14 1, 14 6, 17 1	10 04 3 W			15 3, 16 3	.24629	19		HFJ

SOUTH AMERICA.

BRAZIL—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Vassouras, *B—Continued*	22 24 0 S	316 21	May 25,'13	9 5	10 02.5 W			10 2	.24643	19		HFJ
			May 26, 13			10 6, 13 6	14 27.8 S				19 2	HFJ
			May 26, 13			15 2	14 25 6 S				19 2	HFJ
Puerto Britannia, *A*	24 39 3 S	305 39	Sep 20, 13	9 9, 11 2	0 38 6 W	14 3	14 40 3 S	10 3, 10 9	25242	19	19.126	HFJ
Puerto Britannia, *B*	24 39 3 S	305 41	Sep 22, 13	9.7, 11.0	0 33 6 W	9.0	15 08.6 S	10 2, 11.7	.25156	19	19 26	HFJ
Florianopolis	27 35 8 S	311 26	Jun 4, 13	13 2, 14 9	5 20 4 W			13 7, 14.5	24210	19		HFJ
			Jun 5, 13			9.8	19 38 2 S				19 256	HFJ
Itaquy	29 07 2 S	303 27	Aug 14, 13	9 7, 11 0	2 16 7 E	14.4	21 18 5 S	10 1, 10 7	24932	19	19.1256	HFJ
Sao José do Norte	32 01.3 S	307 57	Jun 10, 13	10.5, 12 9	0 36 8 W	14.1	24 51 2 S	10 9, 11 4	.24154	19	19.126	HFJ
Rio Grande	32 01 5 S	307 52	Jun 11, 13	12 6, 13.8	0 37 0 W	15.0	24 50 8 S	12 9, 13 5	.24146	19	19.126	HFJ

CHILE.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Tacna	18 00 8 S	289 44	Jan 18,'13	10 0, 11.5	8 21 5 E	13.4, 15 0	9 08 7 S	10 4, 11.1	.27848	14	14 1256	HRS
Arica	18 28 8 S	289 40	Jan 16, 13	10.2	7 59 5 E			10 6, 11 5	28016	14		HRS
			Jan 17, 13	8 0, 10 6	8 01 3 E	8 8, 9 8	9 23 9 S			14	14.1256	HRS
Iquique	20 12 6 S	289 50	Jan 21, 13	9 9, 11.7	9 14 2 E	15.1	12 02 4 S	10 4, 11 3	27420	14	14 1256	HRS
			Jan 22, 13			12 3	12 00 1 S				14.1256	HRS
Cebollar	21 29 7 S	291 39	May 16, 12	7 0	8 36 8 E	10 8	13 16 6 S	7 5, 8 4	26969	16	177 6	DM
Calama	22 28 3 S	291 03	May 12, 12	13 3, 14 9	9 15 3 E	17.2	15 12 6 S	13 7, 14 4	26973	16	177 56	DM
Antofagasta	23 38 6 S	289 35	May 7, 12			13.2	18 03 1 S				177 126	DM
			May 8, 12	10 4, 10 7, 12 3	9 46 3 E			11 2, 11.9	26866	16		DM
Coquimbo	29 57.8 S	288 39	Jan 26, 13	10.4, 11 9	11 52 6 E			10 8, 11 5	.26653	14		HRS
Valparaiso, *B*	33 01 5 S	288 19	Jan 31, 13	10 9, 12 6	14 31 2 E			11 3, 12 2	.26258	14		HRS
Valparaiso, *A*	33 04 5 S	288 25	Feb 2, 13	10.0, 12.2	14 05 8 E	15.1	30 29 7 S	10 6, 11 7	.26354	14	14 1256	HRS
			Feb 2, 13			17 0	30 30.8 S				14 1	HRS
Santiago, *A*	33 26.7 S	289 18	Feb 7, 13	11.1, 13 4	13 53 6 E	15.4	30 32 4 S	11 6, 12 8	26510	14	14.1256	HRS
			Mar 29, 13	10.4, 15 6	13 49 4 E	14.2	30 33.1 S	10 9, 11 9	26447	14	14 1256	HRS
			Apr 4, 13	11 2, 11 5	13 48 9 E					14		HRS
Santiago, *B*	33 26 7 S	289 18	Apr 6, 13	14 3, 16 4	13 47 3 E			15 0, 15.9	.26462	14		HRS
			Apr 7, 13			14 3	30 28 0 S				14 1256	HRS
Santiago, *C*	33 27 S	289 18	Mar 28, 13			15.7	30 26 8 S	11 7, 13 0	26377	14	14 1256	HRS
Rancagua	34 11 0 S	289 14	Feb 10, 13	10 1, 11 9	13 51 6 E	14 6	31 13 2 S	10 6, 11 6	.26549	14	14.1256	HRS
Curico	34 59 4 S	288 42	Feb 12, 13	10 3, 11.9	11 14 4 E	14 7	34 02 5 S	10 8, 11 6	25531	14	14 1256	HRS
			Feb 13, 13			11 0	34 01 6 S				14.1256	HRS
Linares	35 51.3 S	288 22	Feb 14, 13	14 2, 15 7	14 54.6 E			14 6, 15 3	.26636	14		HRS
			Feb 15, 13			11 5	33 38 9 S				14 1256	HRS
Chillan	36 36 7 S	287 50	Feb 17, 13	10 4, 13 7	15 05 2 E	15 3	34 53 4 S	10 8, 11.7	.26598	14	14 1256	HRS
Concepcion	36 49 9 S	286 54	Feb 22, 13	9 8, 11.9	15 35 2 E	14 7	35 08 9 S	10 3, 11 5	26666	14	14 1256	HRS
Coronel, *A*	37 01 9 S	286 50	Nov 29, 12	11 7, 15 2, 15 7	15 45 8 E			12.6, 14 8	.26656	2		C II
			Nov 29, 12	17.9, 18 2	15 44.0 E			16 2, 17 4	.26649	2		C II
			Nov 30, 12	10 0, 12 0	15 43 6 E			10 4, 11.6	.26654	2		C II
			Nov 30, 12	12 7, 13.6	15 45 1 E			14 0, 15 4	.26674	19		C II
			Nov 30, 12	15.8, 16 2, 18 3	15 45 6 E			16 6, 17.8	.26664	19		C II
			Dec 1, 12	9 8, 11.6	15 42 8 E			10 2, 11.3	26668	19		C II
			Dec 2, 12			11 7, 16 0	35 29.5 S				19 1256	C II
			Dec 3, 12			10.1	35 29 4 S				19 1256	C II
Coronel, *B*	37 01 9 S	286 50	Nov 28, 12	6 0, 7 0, 9 6	15 44 7 E			10 0, 10 9	.26678	2		C II
			Nov 28, 12	13 1, 17 5, 18 6	15 46.0 E			11 5, 12 6	26673	2		C II
			Nov 28, 12					14 3, 15 5	.26656	2		C II
			Nov 28, 12					16 6	.26665	2		C II
			Nov 29, 12	11 7, 15 2, 15.7	15 44 5 E			12 5, 14 8	.26676	19		C II
			Nov 29, 12	17 9, 18 2	15 44 0 E			16 2, 17 3	.26666	19		C II
			Nov 30, 12	10 0, 12 0	15 44.2 E			10 4, 11 6	26690	19		C II
			Nov 30, 12	12.7, 13 6	15 45.2 E			14 1, 15 4	.26670	2		C II
			Nov 30, 12	15 8, 16 2, 18 3	15 45 6 E			16.6, 17.7	26672	2		C II
			Dec 1, 12	9 8, 11 6	15 42 6 E			10 2, 11 3	26684	2		C II
			Dec 3, 12			11.8, 14.4	35 29 7 S				19.1256	C II
			Dec 3, 12			16 3	35 31 7 S				19 1256	C II
Coronel, *C*	37 01 9 S	286 50	Feb 25, 13	12 1, 13 9	15 47 8 E	15 8	35 34 7 S	12 6, 13.5	.26677	14	14.1256	HRS
San Rosendo	37 16 8 S	287 12	Feb 20, 13	10 0, 11 9	15 28 0 E	14 7	35 26 8 S	10 5, 11.5	26668	14	14 1256	HRS
Victoria	38 15 0 S	287 40	Feb 28, 13	10 6, 12 7	15 31 5 E	15.1	36 02 7 S	11 1, 11 9	26798	14	14 1256	HRS
Temuco	38 43 9 S	287 23	Mar 5, 13	10 3, 11 8	16 00 3 E	14.3	36 46 0 S	10 7, 11 4	26862	14	14 1256	HRS
Loncoche	39 23 4 S	287 12	Mar 7, 13	10 4, 11 8	15 53 4 E	14 8	37 28 0 S	10 8, 11 5	.26818	14	14 1256	HRS
Corral	39 54 1 S	286 29	Mar 9, 13	15 0, 17 0	16 39 0 E			15 5, 16.6	26895	14		HRS
			Mar 10, 13			11 6	38 17.9 S				14 1256	HRS

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Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Osorno	40 35 5 S	286 51	Mar 12,'13	10 3, 12 8, 17 3	16 52 4 E	15 6	39 00 2 S	10 8, 11 7	.26945	14	14 1256	HRS
Puerto Montt	41 29 9 S	287 02	Mar 16, 13	10 5, 17 5	16 26 2 E	15 6	40 35 1 S	10 9, 11 7	26995	14	14 1256	HRS
Puerto Montt, Auxiliary	41 30 S	286 59	Mar 15, 13	10 3	16 37.0 E					14	.	HRS

COLOMBIA.

Station	Latitude	Long East of Gr	Date	Decl. L.M.T.	Decl. Value	Incl. L.M.T.	Incl. Value	Hor. Int. L.M.T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Puerto Villamizar	8 19 4 N	287 32	Dec 26,'12	10.7, 15 0	2 33 0 E	16 9	35 27.6 N	11 6, 14 4	31560	21	21 (343)	ADP

ECUADOR.

Station	Latitude	Long East of Gr	Date	Decl. L.M.T.	Decl. Value	Incl. L.M.T.	Incl. Value	Hor. Int. L.M.T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Esmeraldas, A	0 59 N	280 22	Oct 8,'12					11 1, 11 4	32348	16		ADP
Esmeraldas	0 58 N	280 22	Oct 10, 12	6 5 to 10 9(dv)	6 11 4 E					16		ADP
			Oct 11, 12	9 4, 11 4	6 13 2 E	14 0	20 58 6 N	10 0, 11 0	32390	16	177 1256	ADP

GUIANA.

Station	Latitude	Long East of Gr	Date	Decl. L.M.T.	Decl. Value	Incl. L.M.T.	Incl. Value	Hor. Int. L.M.T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Georgetown	6 48 9 N	301 50	Dec 5,'13			16.2	36 14 7 N				21 (343)4)	ADP
			Dec 6, 13	14 0, 16.4	3 12.2 W			15.3, 16 1	.29686	21		ADP
Wismar	6 00 2 N	301 43	Dec 3, 13	14 2, 16 7	3 39 2 W	12 8	35 01 0 N	15 4, 16 5	29884	21	21 (343)4)	ADP
Rockstone	5 59 N	301 28	Dec 2, 13	8 8, 16 0	3 13 4 W	12 7	35 04 8 N	14 4, 15 6	.29676	21	21 (343)4)	ADP
Siparuni River Mouth	4 50.5 N	301 12	Nov 28, 13	8 6, 10 4	3 01.1 W	11 8	32 43 4 N	9 2, 10 0	29961	21	21 (343)4)	ADP
Apotori	4 02 9 N	301 26	Nov 23, 13	11 7, 13.5	2 46 0 W	15 4	32 18 2 N	12 4, 13 2	29452	21	21 (343)4)	ADP
Yupukarri	3 39.8 N	300 41	Nov 18, 13	9.4, 11.1	2 21 2 W	13 6	31 26 6 N	10 0, 10 8	30238	21	21 (343)4)	ADP
Sauri-Wau River	3 08 1 N	300 08	Nov 6, 13	10 7, 13 7	1 31 6 W	15 5	30 23 6 N	12 5, 13 4	29738	21	21 (343)4)	ADP
Dadanawa	2 49.6 N	300 30	Nov 10, 13	9.5, 12.3	1 48.2 W	14 0	29 42 9 N	10.0, 10 8	30242	21	21 (343)4)	ADP

PARAGUAY.

Station	Latitude	Long East of Gr	Date	Decl. L.M.T.	Decl. Value	Incl. L.M.T.	Incl. Value	Hor. Int. L.M.T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Bahia Negra	20 13.6 S	301 50	Dec 2,'13	9.0, 10 2	1 16 2 E	14 6	8 16 8 S	9.4, 9 9	.26244	19	19 1256	HFJ
Puerto Pinasco	22 39.1 S	302 11	Nov 19, 13	10 0, 11 4	1 27.2 E	8 7	11 51.0 S	10 4, 11 1	.25695	19	19 1256	HFJ
Concepción	23 24 2 S	302 34	Nov 16, 13	10 0, 11.1	1 26 9 E	13 5	13 08 5 S	10 3, 10 8	25646	19	19.1256	HFJ
Villa del Rosario	24 26.0 S	302 52	Nov 14, 13	10 0, 11 2	1 25.4 E	7 6	14 24 1 S	10 3, 10 9	.25434	19	19 256	HFJ
Trinidad	25 15 5 S	302 26	Aug 28, 13	10 3, 11 6	2 08.4 E	13 8	15 39 5 S	10 6, 11 3	25334	19	19 256	HFJ
Sapucay	25 40.1 S	303 03	Aug 30, 13	10 2, 11 4	1 07 9 E	9 6, 14 8	16 18.8 S	10 5, 11 1	.24923	19	19 126	HFJ
			Aug 31, 13			8 8	16 19.1 S				19.126	HFJ
Villa Rica	25 46.9 S	303 34	Sep 5, 13	10 0, 11 2	1 18 4 E	9 0	16 23.6 S	10 4, 10 9	25153	19	19 1256	HFJ
Yegros	26 27.6 S	303 35	Sep 6, 13	9 9, 11 2	1 23 1 E	13.7	16 55 1 S	10 3, 10 9	25003	19	19 256	HFJ
Villa del Pilar	26 51 0 S	301 41	Oct 31, 13	10 0, 11 2	3 22 6 E	8 6	18 06.2 S	10 3, 10 9	25207	19	19 26	HFJ
Yaguarazapa	26 56.2 S	304 45	Oct 8, 13	9 8, 11 2	0 43 8 E	14 4	18 33.4 S	10 2, 10 9	.24856	19	19 256	HFJ
			Oct 9, 13	8 0, 9.0, 10 0	0 40 1 E					19		HFJ
			Oct 9, 13	11 0, 12 0, 13 0	0 45 7 E					19		HFJ
			Oct 9, 13	14 0, 15 0, 16 0	0 47 9 E					19		HFJ
			Oct 9, 13	17 0	0 45 3 E					19		HFJ
Cahi Puente	27 09 8 S	303 46	Sep 9, 13	11.0, 12 4	1 42 5 E	14 1	18 33 2 S	11 3, 11 7	24981	19	19.1256	HFJ
Encarnación	27 19 8 S	304 08	Sep 8, 13	11 4, 13 2	1 00 6 E	14 6	18 05 9 S	11 6, 12 8	24885	19	19 1256	HFJ

PERU.

Station	Latitude	Long East of Gr	Date	Decl. L.M.T.	Decl. Value	Incl. L.M.T.	Incl. Value	Hor. Int. L.M.T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Barranca	4 47 6 S	283 21	Feb 13,'11	9.0, 10 0	6 49.4 E	11 1	11 14 7 N	9 3, 9 8	31120	13	177 1256	CCS
Libertad	4 54 S	283 57	Feb 8, 11	16 4, 17 3	6 47 9 E	17.8, 18 2	10 53 7 N	16.7, 17 1	.31071	13	177.1256	CCS
Paita	5 04 7 S	278 54	Sep 22, 12	9.9, 11.5	7 51.6 E	14 8	9 06 9 N	10 5, 11.2	31698	16	177.1256	ADP
Tres Unidos	5 05.0 S	284 31	Feb 4, 11	17.2, 18.1	6 36 3 E			17 5, 17 8	30918	13		CCS
			Feb 5, 11			15 1	11 07 1 N				177 1256	CCS
Piura	5 11 7 S	279 23	Sep 19, 12	9.1, 11.0	7 52 3 E	14 2	9 14 4 N	9 8, 10 6	31739	16	177 1256	ADP
Chiclayo	6 46 5 S	280 10	Sep 13, 12	9.8, 11 4	7 56 8 E	14 3	6 33 9 N	10 3, 11 1	31179	16	177 1256	ADP
Chilete	7 13 2 S	281 10	Sep 7, 12	10 2, 11 7	7 58 8 E	14 5	5 49.4 N	10 7, 11 4	31172	16	177 1256	ADP
Pacasmayo	7 23 4 S	280 26	Sep 9, 12	10 5, 12 6	8 07 7 E	14 9	5 09 8 N	10 9, 11 5	31183	16	177 1256	ADP

SOUTH AMERICA.

PERU—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Ascope	7 43 0 S	280 55	Sep 1,'12	9 7, 10.1, 11.7	7 49 1 E	14 4	4 59.0 N	10.5, 11 6	31028	16	177 1256	ADP
Trujillo.	8 06 3 S	280 58	Aug 29, 12	9.6, 11 6	8 13 1 E	14 5	4 16.4 N	10 2, 11 2	.30902	16	177 1256	ADP
Masisea, dip station	8 35 S	285 45	Jul 14, 12			15.4	5 10.1 N				171 12(78)	HRS
Masisea[1]	8 38 3 S	285 45	Jul 20, 12			15 6	5 03.0 N				171 12(78)	HRS
			Jul 21, 12	15 1	7 15.3 E			15.7	30228	8		HRS
			Jul 22, 12	9.4, 11 2	7 13 0 E			9 9, 10 8	.30254	8		HRS
Honoria	8 43 3 S	285 35	Jul 7, 12	10 0, 11 6	7 22 0 E	15 2	4 55.8 N	10 5, 11.2	.30128	8	171 12(78)	HRS
Baños	9 03 9 S	285 23	Jul 5, 12	10 1, 13 0	7 17 4 E	15 4	4 40.9 N	10 6, 11 5	.30498	8	171 12(78)	HRS
Chimbote	9 04 1 S	281 25	Aug 26, 12	10 6, 13 0	8 08 8 E	15.2	3 05 9 N	11 1, 12 2	.30523	16	177 1256	ADP
Platanos	9 30 2 S	285 11	Jun 29, 12			11 1, 15 4	3 10 3 N				171.12(78)	HRS
			Jun 30, 12	10 4, 12 5	7 41 8 E	15 6	3 09.5 N	11 0, 12 0	.29866	8	171.12(78)	HRS
Puerto Victoria	9 54 4 S	285 16	Jun 26, 12	14 5, 17 5	7 36 8 E	11 0	2 23 3 N	15 0, 15 9	30010	8	171 12(78)	HRS
Puerto Bermudez	10 17 8 S	285 13	Jun 21, 12	13 0, 14 8	7 50 1 E			13 5, 14 4	.29850	8		HRS
			Jun 22, 12			10 6, 15 6	1 59 7 N				171 12(78)	HRS
			Aug 4, 12	16 4, 18 2	7 49 3 E			16 9, 17 7	.29820	8		HRS
			Aug 5, 12			15 7	2 01 3 N				171 12(78)	HRS
San Nicolas	10 42 3 S	285 07	Jun 14, 12	9 8, 11 4	8 09 9 E	15 0	1 39 7 N	10 3, 11 0	.29910	8	171.12(78)	HRS
			Jun 15, 12	9 4, 13 5, 15 2	8 11 6 E			10 0	29955	8		HRS
			Jun 15, 12					13 9, 14.7	29886	8		HRS
Eneñas	10 45 0 S	284 50	Jun 9, 12			14 9	1 09 3 N				171 12(78)	HRS
			Jun 10, 12	14 5, 16 6	8 08 4 E			15 0, 16 0	.29895	8		HRS
La Fundicion	10 46 2 S	283 46	Sep 17, 12			14 2	0 33 6 N				14 1256	HRS
			Sep 18, 12	10 4, 12 1	8 24 2 E			10 9, 11 7	.30078	14		HRS
La Merced	11 03 9 S	284 39	Jun 4, 12	9 8, 11 6	8 10 2 E	14 3	0 30 8 N	10 4, 11 2	29804	8	171.12(78)	HRS
La Merced, Secondary	11 03 9 S	284 39	May 27, 12			15.2	0 29 1 N				171 12(78)	HRS
Huacho	11 07.0 S	282 21	Aug 18, 12	9 8, 13 4	8 38 4 E	15 6	0 37 0 S	11 3, 12 4	30270	16	177 1256	ADP
			Sep 1, 12	13 1, 15 2	8 38 6 E			13 7, 14 6	30269	14		HRS
Tarma	11 26 0 S	284 18	May 23, 12	9 9, 13 2	8 30 2 E	14 8	0 12 0 S	10 4, 11 2	29892	8	171 12(78)	HRS
Oroya	11 32 6 S	284 05	May 21, 12	10 3, 11 6	8 40 6 E	14 0	0 58.6 S	10 8, 11 3	30058	8	171 12(78)	A&S
Jauja	11 46 8 S	284 31	Sep 20, 12	8 8, 11 5	8 30 8 E	15 2	0 47 5 S	9 3, 11 0	29845	14	14 1256	HRS
			Sep 21, 12	9 2, 11 3	8 29 0 E			9 7, 10 7	29834	14		HRS
Matucana	11 50 9 S	283 38	Sep 14, 12	9 7, 11 5	8 43 6 E	15 6	1 47 4 S	10 2, 11 0	30038	14	14 1256	HRS
Lima (Hipodromo)	12 04 4 S	282 58	Apr 20, 12	16 2	8 53 1 E	13 7	2 01 5 S	17 1	.29980	16	177 1256	DM
			Apr 23, 12	10 8, 13 2	8 54 8 E	15.4	2 03 3 S	11 2, 12.3	30068	16	177 1256	DM
			Apr 25, 12	10 4, 12.6	8 51 4 E			10 9, 12 1	30018	16		A&M
			Apr 25, 12	14 2, 16 2	8 52 2 E			14.6, 15.5	.29998	16		A&M
			Apr 26, 12	10 0, 12 1	8 52 4 E			10 5, 11.6	30060	14		A&M
			Apr 26, 12	13 9, 15 7	8 54 1 E			14 4, 15 3	30015	14		A&M
			May 2, 12	15 6	8 55 3 E			16 4	29979	8		HRS
			May 3, 12	10 7, 13 0	8 55 0 E			11 3, 12 4	30029	8		HRS
			May 6, 12	10 7, 13 6	8 56 2 E	16 6	2 02 2 S	11 5, 13 0	.30012	8	171.2(78)	HRS
			May 7, 12	12 9, 15 2	8 56 8 E	10.1	2 00 2 S	13.5, 14 6	30001	8	171.12(78)	HRS
			May 9, 12	9 9, 11 8	8 51 8 E	14 4	1 58 7 S	10 5, 11 4	.30003	8	171.12(78)	HRS
			Aug 18, 12	11 0, 12 8	8 51.3 E			11 6, 12 4	.29980	8		A&S
			Aug 19, 12	9 8, 11 5	8 51.1 E			10 3, 11.0	.30039	14		A&S
			Aug 21, 12	12 0, 15 1	8 53 4 E	16.8	1 59 0 S	13 3, 14.5	30002	16	177.1256	ADP
Lima, *A*	12 04.4 S	282 58	Apr 25, 12	10 4, 12 6	8 51.4 E			10 9, 12 0	30032	14		A&M
			Apr 25, 12	14.2, 16 3	8 52 4 E			14.6, 15 5	29980	14		A&M
			Apr 26, 12	10 0, 12 1	8 55.0 E			10 5, 11 6	.29998	16		A&M
			Apr 26, 12	13.9, 15.7	8 57.4 E			14 4, 15 3	.29998	16		A&M
			Aug 18, 12	11.0, 12 8	8 50 8 E			11.6, 12 4	30019	14		A&S
			Aug 19, 12	9 8, 11 5	8 52 4 E			10 3, 11 1	.30033	8		A&S
			Aug 21, 12	12 0, 15 1	8 52.6 E			13 3, 14 5	29989	14		HRS
Huancayo	12 04 5 S	284 46	Sep 23, 12	9 2, 11.1	8 32 1 E	14.4	1 09 0 S	9 8, 10 6	29784	14	14.1256	HRS
			Sep 24, 12			13 7	1 11 0 S				14 1256	HRS
San Lorenzo Island	12 05 5 S	282 49	May 1, 12	10 6, 11 7	9 04 0 E	14 0	2 32 8 S	11 0, 11 4	30037	14	14 1256	JPA
Yzcuchaca	12 29 9 S	284 58	Sep 29, 12	9 4, 12 6	8 02 8 E	15 0	1 12 7 S	10 4, 11 5	29439	14	14 1256	HRS
Acobamba	12 51 4 S	285 23	Oct 3, 12	9 7, 11 5	8 30 2 E	14 8	2 16.9 S	10 4, 11 1	.29537	14	14 1256	HRS
			Oct 4, 12			12 0	2 15 4 S				14 1256	HRS
Ayacucho	13 09.8 S	285 43	Oct 10, 12	6 1, 11 2	8 37 9 E			13.7, 14.6	29152	14		HRS
			Oct 10, 12	6 2 to 11 0(dv)	8 37 5 E					14		HRS
			Oct 12, 12			10 5	3 10 6 S				14 1256	HRS
Hacienda Pajonal	13 25 2 S	286 04	Oct 15, 12	15 2, 17 0	8 17 8 E			15 7, 16 5	29286	14		HRS
			Oct 16, 12			10 4	2 56.7 S				14.1256	HRS
Limatambo	13 30 0 S	287 28	Oct 28, 12	9 3, 11 1	7 21 6 E	15 2	2 34.1 S	9 8, 10 7	.29302	14	14 1256	HRS
Cuzco	13 31 7 S	287 57	Nov 1, 12	8 4, 11 0	7 55 0 E	14 7	2 20 6 S	9 6, 10 6	29205	14	14 1256	HRS
			Nov 2, 12	9 8, 12 3	7 53 9 E	14 6	2 17 0 S	10 3, 11 2	29185	14	14 1256	HRS

[1] Latitude as given in Vol I, p 94, should read 8° 38′ S instead of 8° 35′ S

SOUTH AMERICA.

PERU—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L M. T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Abancay	13 37 5 S	287 03	Oct 24,'12	9.9, 12 8	8 14 3 E	14 5	2 40.0 S	10 4, 11.2	.29142	14	14 1256	HRS
Andahuaylas	13 39 7 S	286 34	Oct 19, 12	13.8, 15 8	8 16 0 E			14 4, 15 3	.29112	14		HRS
			Oct 20, 12			10.7	2 28.4 S				14 1256	HRS
Urcos	13 41 4 S	288 18	Nov 6, 12	9.6, 11 2	7 56 4 E	14.8	2 07.9 S	10 0, 10 8	.29054	14	14 1256	HRS
Pisco	13 42 4 S	283 46	Aug 13, 12	13.4, 15.2	9 12 1 E	17.0	4 15 2 S	14 0, 14 8	.29431	16	177.1256	ADP
Ica	14 04 7 S	284 14	Aug 10, 12	10.5, 13.5	9 07.1 E	16 3	4 54 8 S	11 5, 13 0	.29122	16	177.1256	ADP
Sicuani	14 16 4 S	288 40	Nov 9, 12	9.7, 11 3	7 52.2 E	14 7	3 10.4 S	10 1, 10 9	.28804	14	14.1256	HRS
Santa Rosa	14 37 1 S	289 08	Nov 12, 12	9 3, 11.0	7 45.2 E			9 8, 10.6	28720	14		HRS
			Nov 13, 12			9 9	3 26 6 S				14 1256	HRS
Tirapata	14 57 5 S	289 34	Nov 14, 12	8 6, 11 1	7 41 1 E	13 2	3 57 8 S	10 0, 10 7	28433	14	14.1256	HRS
Juliaca	15 30 2 S	289 50	Nov 16, 12	9 2, 11 0	7 43 2 E	14 3	4 38 9 S	9 7, 10 6	28369	14	14.1256	HRS
Santa Lucia	15 42 4 S	289 18	Dec 13, 12	9 9, 11.4	7 36 1 E	14 1	4 23 1 S	10 3, 11 0	28561	14	14.1256	HRS
Puno	15 50 6 S	289 55	Nov 19, 12			15 8	5 34 2 S				14.1256	HRS
			Nov 20, 12	10 1, 12 1	8 03.3 E	14 4	5 37.4 S	10 5, 11 2	.28260	14	14.1256	HRS
Chala	15 53 0 S	285 45	Aug 5, 12	9 8, 11 7	9 04 5 E	14 4	7 16.2 S	10 4, 11 3	28389	16	177.1256	ADP
Pampa de Arrieros	16 04 1 S	288 18	Dec 15, 12	10 2	8 14.7 E			10.6, 11 3	28548	14		HRS
			Dec 16, 12	8 5, 11.9	8 16 3 E	9 4, 11.0	5 53.7 S			14	14 1256	HRS
Juli	16 12 3 S	290 24	Nov 24, 12			15 7	5 21 8 S				14 56	HRS
			Nov 25, 12	9.8, 11 2	7 42 2 E	14 2	5 23 4 S	10 2, 10.9	28186	14	14.1256	HRS
Arequipa	16 22 5 S	288 27	Jul 22, 12	10 4, 12 5	8 18 5 E	14 3	6 40 3 S	10 8, 11 4	28428	16	177.1256	A&P
			Jul 23, 12	10.1, 12.2	8 17.0 E	15 6	6 43 6 S	10 8, 11 7	.28437	16	177 1256	A&P
			Jul 24, 12	10 7, 13 6	8 17.7 E	15 8	6 42.2 S	11 3, 12 5	.28438	16	177 1256	A&P
			Jul 25, 12	10 9, 13.2	8 16 4 E			11 6, 12 6	28438	14		A&P
			Jul 25, 12	14 3, 16 2	8 17.9 E			14 8, 15 7	.28392	14		A&P
			Jul 26, 12	9 0, 9 8, 11 8	8 17 3 E			10 4, 11 3	28410	16		A&P
			Jul 26, 12	13 8, 15 7	8 19.5 E			14 4, 15.2	.28397	16		A&P
			Dec 22, 12	8 2, 9 6	8 13.6 E	12 0	6 38 4 S	8 6, 9 3	.28458	14	14 1256	HRS
			Dec 23, 12			11.4	6 37 7 S				14 1256	HRS
Arequipa, Secondary	16 22 5 S	288 27	Jul 25, 12	10.9, 13 2	8 22.2 E			11.6, 12.6	.28442	16		A&P
			Jul 25, 12	14 3, 16.2	8 24.4 E			14 8, 15.7	.28412	16		A&P
			Jul 26, 12	9 0, 9 8, 11.8	8 23.2 E			10.4, 11.3	28418	14		A&P
			Jul 26, 12	13 8, 15.7	8 25.7 E			14.4, 15.1	.28403	14		A&P
			Jul 27, 12	10.1, 11 6	8 23.8 E	14.2	6 56.6 S	10.5, 11.2	.28441	16	177.1256	A&P
Mollendo	17 01 8 S	287 59	Aug 2, 12	11.1, 13.8	8 24 9 E	15.9	8 21 7 S	11 7, 13.1	27922	16	177.1256	A&P
			Jan 11, 13	10 9, 12.7	8 23.7 E	15 1	8 19.7 S	11 4, 12.3	.27970	14	14 1256	HRS

URUGUAY.

Station	Latitude	Long. East of Gr.	Date	Declination LMT	Declination Value	Inclination LMT	Inclination Value	Hor. Intensity LMT	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
San Eugenio	30 23.7 S	303 36	Aug 11,'13	10 3, 11.6	2 28 2 E	13.7	21 59.1 S	10 8, 11.4	.24421	19	19 1256	HFJ
Rivera	30 55.2 S	304 32	Jul 30, 13	9.6, 11.0	2 12.8 E	13.8	23 17 2 S	10.0, 10.7	.24466	19	19 1256	HFJ
Tacuarembo	31 42 S	304 08	Jul 31, 13			16 0	24 31.4 S				19.1256	HFJ
			Aug 1, 13	8 6, 10 1, 10.9	2 26 3 E			9 1, 9 8	24621	19		HFJ
Melo	32 22 9 S	305 53	Jul 12, 13	9 2, 10 4	1 09.4 E	14 3	24 47 1 S	9 6, 10 2	.24441	19	19.1256	HFJ
Treinta y Tres	33 14 1 S	305 40	Jul 15, 13	11.2, 13.0	2 35 3 E	14 6	26 47.0 S	11.6, 12 7	.24452	19	19 1256	HFJ
Mercedes	33 15.4 S	302 00	Jul 20, 13	9.4, 10 8	5 01 2 E	14 4	26 25 4 S	9 8, 10.4	.24836	19	19 1256	HFJ
Durazno	33 21.9 S	303 27	Jul 27, 13	9.8, 11 1	3 35 6 E	14 1	26 15.6 S	10 2, 10 8	.24750	19	19.1256	HFJ
			Jul 27, 13					11 4	.24749	19		HFJ
Cerro Colorado	33 50 6 S	304 29	Jul 17, 13	10 1, 11.4	2 52 0 E	14 5	26 45 7 S	10 5, 11 2	.24507	19	19 1256	HFJ
Colon	34 48 3 S	303 46	Jul 3, 13	10 6, 11 8	3 51 0 E	15 1	27 51 4 S	11 0, 11 6	.24751	19	19.1256	HFJ
			Jul 4, 13	9 0, 10.0	3 49 4 E	11 2	27 45 5 S			19	19.1256	HFJ
			Jul 4, 13	13.6, 14 0	3 52 0 E					19		HFJ
Montevideo	34 52 7 S	303 49	Jul 2, 13	10.4, 11.6	3 48 4 E	14 2	27 54.3 S	10.8, 11 4	.24704	19	19.126	HFJ
Punta del Este	34 57.9 S	305 06	Jul 7, 13	9.7, 10 8	2 52 0 E	14 3	27 55 2 S	10 1, 10.6	24566	19	19 1256	HFJ

SOUTH AMERICA.

VENEZUELA.

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L. M. T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Maracaibo	10 40 6 N	288 23	Dec 20,'12	11 0, 14 4	1 49 4 E	16 9	39 17 3 N	11 5, 13 9	.31194	21	21 (343)4)	ADP
Carupano	10 40 N	296 45	Apr 8, 13	10 2, 12 3	1 43 4 W	15 4	40 43 1 N	10 8, 11 8	30156	21	21 (343)4)	ADP
Caracas	10 30 4 N	293 04	Nov 7, 12		.	16 2	39 49 5 N	.	. .		177 1256	ADP
			Nov 8, 12	10 4, 13 1	0 03 1 E	.	.	11.0, 12.1	.30622	16	.	ADP
			Nov 9, 12	10 7, 13 4	0 03 4 E	16 3	39 48 2 N	11 5, 12 6	.30616	21	21 (43)4)	ADP
			Nov 10, 12	9 8, 12 2	0 02 2 E	.		10.6, 11.6	.30592	21		ADP
			Nov 10, 12	14 2, 15 8	0 00 9 E	. . . .	. .	14 6, 15.4	.30563	16	. . .	ADP
			Feb 14, 13	10 3, 12 8	0 02 2 E	15 6	39 53 1 N	11 1, 12 2	.30564	21	21.(34)4)	ADP
Puerto Cabello	10 28 2 N	291 59	Nov 19, 12	9 8, 12 2	0 27 8 E	15 3	39 39 3 N	10 4, 11 3	.30765	21	21.(34)4)	ADP
Cumana	10 28.1 N	295 47	Apr 1, 13	9.3, 11 4	1 15 4 W	14.7	40 20 8 N	9 9, 10 8	.30326	21	21 (343)4)	ADP
Aroa	10 26 9 N	291 07	Nov 23, 12	9.6, 11 5	0 53 0 E	14 9	39 22 8 N	10 1, 11 0	.30840	21	21 (343)4)	ADP
Turmero	10 14 3 N	292 30	Nov 16, 12	9 9, 12.5	0 19 6 E	16 2	39 16 0 N	10 6, 12 1	.30726	21	21 (343)4)	ADP
Barcelona	10 08 3 N	295 18	Mar 28, 13	9 6, 11 8	0 51 0 W	15 4	39 43 9 N	10 4, 11 3	.30344	21	21.(343)4)	ADP
Barquisimeto	10 04 4 N	290 41	Nov 26, 12	9 6, 11 8	1 05 3 E	15 0	38 43.4 N	10 4, 11 3	30970	21	21.(343)4)	ADP
Pedernales	9 58 N	297 43	May 28, 13	14 9, 17 6	2 05 9 W	. .	.	16 1, 17 0	.29922	21	... . .	ADP
			May 29, 13	8 6	2 04 5 W	13 3	40 08.0 N	10 1	.29954	21	21.(343)4)	ADP
Tocuyo	9 47 4 N	290 12	Nov 29, 12	10 1, 12 5	1 22 1 E	15 3	38 09 4 N	10 7, 11 4	.31062	21	21 (343)4)	ADP
Carache	9 38 5 N	289 46	Dec 4, 12	10 4, 13 6	1 30 4 E	16 5	37 52 0 N	10 9, 13.2	31112	21	21.(343)4)	ADP
La Ceiba	9 28 1 N	288 56	Dec 17, 12	9 8, 11 7	1 48 8 E	15 5	37 33 6 N	10 5, 11 4	31276	21	21.(343)4)	ADP
Sabana de Mendoza	9 27 0 N	289 12	Dec 14, 12	10 6, 12 6	1 38 0 E	15.3, 16 1	37 30 8 N	10 9, 12 0	.31217	21	21 (3)4)	ADP
Trujillo	9 22 6 N	289 33	Dec 9, 12	10 2, 12.8	1 33 8 E	15 6	37 27.3 N	10 8, 11 5	31176	21	21 (343)4)	ADP
			Dec 9, 12	. ..	. .	..	. . .	12 3	.31191	21		ADP
Tucupita	9 03 6 N	297 56	May 30, 13	16 2, 18 0	1 48 6 W	.		16 8, 17 6	29919	21	. . .	ADP
			May 31, 13	. .	. .	8 7	38 35 4 N	. .... .	. .	..	21 (343)4)	ADP
Barrancas	8 42 N	297 48	Jun 1, 13	8 2, 11 0	1 07.1 W	14 5	38 35 4 N	9 7, 10 5	29625	21	21 (343)4)	ADP
San Felix	8 22 4 N	297 22	Jun 3, 13	8 5, 10 6	0 47.0 W	13 6	37 52 7 N	9 2, 10 1	.29552	21	21.(343)4)	ADP
Ciudad Bolivar	8 09 1 N	296 28	Jun 5, 13	10 5, 12 6	1 00 9 W	15 5	37 18 8 N	11 0, 12 0	.30554	21	21 (343)4)	ADP
Moitaco	8 00 7 N	295 39	Jun 12, 13	8 8, 11 4	0 39 4 W	14 2	36 54.4 N	10 1, 11 0	.30452	21	21.(343)4)	ADP
Las Bonitas	7 52 6 N	294 19	Jun 15, 13	10 2, 12 6	0 16 6 E	14 9	36 34 4 N	10 8, 11 5	30568	21	21 (343)4)	ADP
El Tigre	7 49 N	294 51	Jun 14, 13	10 4, 12 7	0 07 0 W	14 9	36 37.7 N	11 3, 12 3	30533	21	21.(343)4)	ADP
Mapire	7 44 5 N	295 18	Jun 13, 13	9 4, 11 5	0 14 9 E	14 8	37 06 7 N	10 1, 11 0	.29436	21	21 (343)4)	ADP
Caicara	7 38 5 N	293 48	Jun 17, 13	14 1, 17 1	0 31 7 E	. . . .	.	16 0, 16 8	30712	21	.... .	ADP
			Jun 18, 13	.. ...	.	12 1	36 22.6 N			.	21 (343)4)	ADP
Casimirito	7 25 0 N	293 28	Jun 20, 13	10 4, 13 1	0 22 2 E	16 3	35 39 3 N	11 1, 12 7	30478	21	21 (343)4)	ADP
La Urbana	7 08.3 N	293 03	Jun 21, 13	10 7, 13.0	0 46 6 E	16 4	35 13.1 N	11.4, 12 5	.30606	21	21 (343)4)	ADP
Santa Maria	6 35 8 N	292 50	Jun 23, 13	9 6, 11 7	1 26 3 E	14 6	34 23 0 N	10 3, 11.3	30754	21	21 (343)4)	ADP
Zamuro	5 38 9 N	292 20	Jun 26, 13	14 8, 17 5	1 31 6 E	. .	.. .	16 2, 17.1	30984	21	.. ..	ADP
			Jun 27, 13		.	14 8	32 33 0 N	.	.		21 (343)4)	ADP
Maipures	5 12 6 N	292 10	Jul 1, 13	9 9, 11 8	1 34 0 E	15 4	31 55 6 N	10 6, 11 4	30712	21	21 (343)4)	ADP
Marida	4 38 7 N	292 09	Jul 4, 13	10 6, 12 7	1 23 8 E	15 7	31 25 2 N	11.1, 12 1	30762	21	21 (343)4)	ADP
San Fernando de Atabapo	4 02 6 N	292 19	Jul 7, 13	15 9, 18 0	1 46 6 E	..	.	16 8, 17 6	30705	21	....	ADP
			Jul 8, 13			11 4	30 29 6 N	.	..		21.(343)4)	ADP
Baltazar	3 27.2 N	292 41	Jul 11, 13	9 6, 12 8	1 46 4 E	16 6	29 32 9 N	11 2, 12 2	30802	21	21 (343)4)	ADP
Yavita	2 55 3 N	292 35	Jul 14, 13	10 2, 12 6	2 10 0 E	16 6	28 21 1 N	11 0, 11 7	.30880	21	21 (343)4)	ADP
Comunidad	2 23 1 N	292 50	Jul 20, 13	16 9	3 02 2 E	...	... .	. ..	. .	21	.	ADP
			Jul 21, 13	8 7, 12 5	3 04 8 E	14 2	29 00 1 N	9 2, 10 0	31690	21	21 (343)4)	ADP
San Carlos*	1 55.2 N	292 59	Jul 23, 13	10 6, 12 3	4 26 0 E	15 5	22 18 6 N	11 1, 11 8	.31407	21	21 (343)4)	ADP

*Local disturbance.

ISLANDS, ATLANTIC OCEAN.

CANARY ISLANDS.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
recife	28 57 1 N	346 28	Jun 26,'12	9 2, 11 0	17 14 0 W	14 2	48 11 9 N	9 7, 10 6	28645	7	202 125	WHS
anta Cruz, *1911**	28 28 6 N	343 47	Mar 4, 11	10.0, 11 2	14 40 9 W					8		HFJ
			Mar 6, 11					9 4, 10 5	25620	8		HFJ
anta Cruz, *1912**	28 24 5 N	343 47	May 20, 12	9 1, 11 2	18 18 3 W	14 1	44 24 4 N	9 6, 10 6	27845	7	202 1257	WHS
as Palmas	28 07 6 N	344 35	Mar 1, 11	10 0, 11 7	17 20 6 W	16 8	46 57 0 N	10 4, 11 3	27224	8	172 156	HFJ
			May 18, 12	9 4, 11 2	17 15 3 W	14.3	46 49 2 N	9 9, 10 9	27290	7	202.1257	WHS
lorro Jable Point	28 02 N	345 40	Jun 10, 12	13 2, 14 4	17 09 0 W	16 8	47 08 4 N	13 8	28442	7	202 2	WHS

FALKLAND ISLANDS.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
ort Stanley, *A*	51 41 2 S	302 10	Feb 3,'13	10 2, 12.4	10 11 2 E	14 2	45 46.7 S	10 9, 11 8	26486	19	201 125	C II
ort Stanley, *B*	51 41 8 S	302 08	Feb 6, 13	9 6, 13 0	10 16 6 E			10.3, 11 1	26472	19		C II
			Feb 6, 13					11 8, 12 5	26486	19		C II
			Feb 10, 13	16 4, 17 4	10 14 8 E	11 3, 11 8	45 50 8 S			19	EI 2	C II
			Feb 10, 13			12 2, 12 5	45 51.2 S				EI 2	C II
			Feb 10, 13			12 8, 13.1	45 51.2 S				EI 2	C II
			Feb 10, 13			15 0, 15 4	45 51.0 S				EI 2	C II
			Feb 10, 13			15 6	45 51.0 S				EI 2	C II
			Feb 11, 13			11 9, 12.3	45 50 9 S				EI 2	C II
			Feb 11, 13			12 6, 15.7	45 50 8 S				EI 2	C II
			Feb 11, 13			16.1	45 50 4 S				EI 2	C II
			Feb 12, 13	15 4, 17.1	10 16.3 E	10 9, 11 6	45 53.7 S	15.9, 16 7	.26479	19	EI 3	C II
			Feb 12, 13			12 2, 12.9	45 52 8 S				EI 3	C II
			Feb 13, 13	10.2, 11.7	10 15 2 E			10 6, 11.3	26450	19		C II
			Feb 13, 13	12.2, 14.8	10 18.7 E			12.5, 14 5	.26454	19		C II
			Feb 13, 13	15 4, 16.9	10 16 3 E			15 7, 16 5	.26478	2		C II
			Feb 14, 13	9.8, 11.5	10 16.8 E			10 3, 11.1	.26471	2		C II
			Feb 14, 13	12.0, 15.4	10 18 2 E			12 4, 14 9	.26474	2		C II
			Feb 17, 13	16.5, 19.0	10 14.6 E					19		C II
			Feb 20, 13	7 7, 9.3, 13.1	10 14.0 E			9.8, 10 7	.26456	19		C II
			Feb 20, 13					11 3, 12.7	26453	19		C II
			Feb 20, 13					14 1	.26456	19		C II
ort Stanley, *C*	51 41.8 S	302 08	Feb 7, 13	10.9	10 16.2 E			11.4, 12 3	26496	19		C II
			Feb 7, 13					14 2	26507	19		C II
			Feb 8, 13			12.4, 12 9	45 51.9 S				EI 2	C II
			Feb 8, 13			14.7, 15.1	45 50 0 S				EI 2	C II
			Feb 8, 13			15 6, 16.1	45 50 7 S				EI 2	C II
			Feb 10, 13	6.7, 7 8	10 12.3 E					19		C II
			Feb 11, 13			12.0, 12.3	45 51.9 S				EI 3	C II
			Feb 11, 13			15.5, 16 0	45 52 0 S				EI 3	C II
			Feb 12, 13	15.4, 17 1	10 16 8 E	10 9, 11.7	45 52 8 S	15.9, 16 7	26491	2	EI 2	C II
			Feb 12, 13			12.3, 12 8	45 52 4 S				EI 2	C II
			Feb 13, 13	10.2, 11.7	10 14 5 E			10 6, 11 3	.26460	2		C II
			Feb 13, 13	12 2, 14.8	10 17.2 E			12 5, 14 5	.26470	2		C II
			Feb 13, 13	15 4, 16 9	10 17 4 E			15 7, 16 5	26460	19		C II
			Feb 14, 13	9 8, 11 5	10 15 8 E			10 3, 11 1	.26450	19		C II
			Feb 14, 13	12.0, 15 4	10 16 9 E			12 4, 14 9	.26462	19		C II
			Feb 18, 13	11 6, 17.7	10 14 8 E			12 8, 15 2	.26470	19		C II
			Feb 18, 13					15 9, 17.0	26438	19		C II
			Feb 20, 13			13 9, 14.2	45 54.9 S				EI 3	C II
			Feb 20, 13			14.6, 14.9	45 54 4 S				EI 3	C II

ST. HELENA.

Station	Latitude	Long East of Gr	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Longwood, *A**	15 56 7 S	354 19	Apr 8,'13	11 4, 12 7	25 12 0 W			11.8, 12 4	22126	19		C II
			Jun 26, 13	12.0, 14.3, 16.2	25 11.5 W			14 7, 15 6	.22080	4		C II
			Jun 27, 13	9 8, 12.0	25 11.4 W			10 4, 11.3	.22099	4		C II
			Jun 27, 13	12 9, 15 0	25 12.2 W			13.2, 14 3	.22097	4		C II
			Jun 27, 13	15 6, 17.4	25 09.4 W			16 0, 16 9	22088	2		C II
			Jun 28, 13	9 9, 12 1	25 10 4 W			10 4, 11.3	22122	2		C II
			Jun 28, 13	12 8, 14 6	25 09 4 W			13 2, 14 1	.22092	2		C II
			Jun 30, 13			11.9, 13 2	36 38 0 S				EI 2	C II
			Jun 30, 13			13 6, 14 2	36 38 5 S				EI 2	C II
			Jun 30, 13			14 6, 14 9	36 38 9 S				EI 2	C II

*Local disturbance.

ISLANDS, ATLANTIC OCEAN.

ST HELENA—*Concluded.*

Station	Latitude	Long East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Longwood, *A**—*Continued*	15 56 7 S	354 19	Jun 30,'13			15 4, 15 7	36 38 8 S				EI 2	C II
			Jul 1, 13			11 1, 12 0	36 38 2 S				EI 2	C II
			Jul 1, 13			14 0, 14 7	36 39 2 S				EI 2	C II
			Jul 1, 13			15 1, 15 6	36 39 6 S				EI 2	C II
			Jul 1, 13			16 0, 16 4	36 39.8 S				EI 2	C II
			Jul 2, 13	17 1, 17 6	25 11 2 W	10 5, 10 8	36 38 0 S			4	EI 3	C II
			Jul 2, 13			11 2, 11 4	36 37.6 S				EI 3	C II
			Jul 2, 13			11.6, 11 7	36 37 6 S				EI 3	C II
			Jul 2, 13			11 9, 12.1	36 39 9 S				EI 3	C II
			Jul 2, 13			13 4, 13 6	36 39.1 S				EI 3	C II
			Jul 2, 13			14.0, 14 1	36 39 2 S				EI 3	C II
			Jul 2, 13			14 3, 14 6	36 39.2 S				EI 3	C II
			Jul 2, 13			15 1, 15 4	36 39 8 S				EI 3	C II
			Jul 2, 13			15 8, 16 1	36 40 5 S				EI 3	C II
			Jul 2, 13			16 4	36 41 6 S				EI 3	C II
			Jul 7, 13	10 4, 12 3, 13 1	25 08 2 W			10 9, 11 8	22092	2		C II
			Jul 7, 13	14 6, 15 0, 16 8	25 09 0 W			13 5, 14 2	22102	2		C II
			Jul 7, 13					15 4, 16 3	22072	2		C II
Longwood, *B**	15 56 7 S	354 19	Jun 30, 13			11 8, 12 3	36 45 7 S				EI 3	C II
			Jun 30, 13			13 2, 13 4	36 45 7 S				EI 3	C II
			Jun 30, 13			13 7, 13 9	36 46 9 S				EI 3	C II
			Jun 30, 13			14 2, 14 4	36 46 6 S				EI 3	C II
			Jun 30, 13			14 8, 15 0	36 47 3 S				EI 3	C II
			Jun 30, 13			15 4, 15 6	36 47.0 S				EI 3	C II
			Jun 30, 13			15 9	36 48 2 S				EI 3	C II
			Jul 3, 13	10 0, 11 5, 12 5	24 43.8 W			10 4, 11 2	22072	4		C II
			Jul 3, 13	13 5, 13 9, 15 0	24 43 6 W			12 8, 13 3	22070	4		C II
			Jul 3, 13					14 2, 14 7	22068	4		C II
			Jul 3, 13					15 6	22059	4		C II
			Jul 7, 13	10 4, 12 3, 13 1	24 41 7 W			10 9, 11 8	22077	4		C II
			Jul 7, 13	14 6, 15 0, 16 8	24 42 3 W			13 5, 14 2	.22064	4		C II
			Jul 7, 13					15 4, 16 3	.22042	4		C II
			Jul 15, 13	10 2, 11 8	24 42 8 W					4		C II
Longwood, *C**.	15 56 7 S	354 19	Jun 26, 13	12 0, 14 3, 16 2	25 03 2 W			13 0, 14.7	21555	2		C II
			Jun 26, 13					15 6	21550	2		C II
			Jun 27, 13	9 8, 12 0	25 03 6 W			10 4, 11 3	21573	2		C II
			Jun 27, 13	12 9, 15 0	25 04 6 W			13 3, 14 3	21568	2		C II
			Jun 27, 13	15 6, 17 4	25 04 8 W			16 0, 16 9	21534	4		C II
			Jun 28, 13	9 9, 12 1, 12 8	25 05 9 W			10 4, 11 3	21588	4		C II
			Jun 28, 13	14 6, 16 8, 17 4	25 04.7 W			13 2, 14 2	.21557	4		C II
			Jul 1, 13			10 5, 10 9	37 36 8 S				EI 3	C II
			Jul 1, 13			11 2, 11.5	37 36 9 S				EI 3	C II
			Jul 1, 13			11 8, 12 0	37 36.1 S				EI 3	C II
			Jul 1, 13			12 2, 12.4	37 37.3 S				EI 3	C II
			Jul 1, 13			13 8, 14 4	37 36 9 S				EI 3	C II
			Jul 1, 13			14 8, 15 2	37 36 8 S				EI 3	C II
			Jul 1, 13			15.6, 15.8	37 37 5 S				EI 3	C II
			Jul 1, 13			16 2 ...	37 37 3 S				EI 3	C II
			Jul 2, 13			11 5, 12 0	37 34 5 S				EI 2	C II
			Jul 2, 13			12 3, 12 6	37 36 2 S				EI 2	C II
			Jul 2, 13			13 3, 13 8	37 36 8 S				EI 2	C II
			Jul 2, 13			14.1, 14 4	37 37 0 S				EI 2	C II
			Jul 2, 13			15 2, 15 6	37 37 6 S				EI 2	C II
Longwood, *D**	15 56 7 S	354 20	Jul 8, 13	15 4, 17 4	26 07 2 W			15 9, 17 0	.22805	4		C II
			Jul 15, 13			10 3, 10 8	35 25 6 S				201 12	C II

WEST INDIES.

	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Willemstad	12 06 7 N	291 03	Feb 4,'13	11 6, 14 6	0 20.9 E	17.0	41 51.2 N	12 4, 14.1	.30648	21	21 (343)4)	ADP
Port of Spain	10 40 6 N	298 28	Apr 17, 13	10 5, 12 6	2 44 8 W	14 7	40 57 2 N	11.1, 12 2	29991	21	21 (343)4)	ADP

*Local disturbance

ISLANDS, INDIAN OCEAN.

CEYLON.

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T.	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Colombo, Cinnamon Gardens	6 58 1 N	79 52	Sep 12,'11	12.7, 14 6	2 02 2 W			13 2, 14 2	37874	4		C II
			Sep 13, 11			10 7	4 37 5 S				201 256	C II
Colombo, *A*	6 54 2 N	79 52	Jun 13, 11	10 6, 14.3, 14 7	1 35 4 W			11 4, 13 8	37991	4		C II
			Jun 13, 11					15 2, 16.2	37950	4		C II
			Jun 14, 11	9 8, 10 0	1 34 6 W			10.7, 11 5	38022	4		C II
			Jun 14, 11	10 3, 11 9	1 34 4 W					4		C II
			Jun 14, 11	13 7, 16 6	1 35 6 W			14 3, 16 0	.37981	2		C II
			Jun 15, 11	10 1, 12 5	1 35 6 W			10 8, 12 0	37992	2		C II
			Jun 15, 11	13 6, 15 8	1 34 7 W			14 1, 15 3	38020	2		C II
			Jun 16, 11	8 2, 9 8, 10.0	1 34 1 W			8 6, 9 5	38031	2		C II
			Jun 16, 11	13 6, 13.8, 15 6	1 35 3 W			10 3, 13 3	37996	2		C II
			Jun 16, 11	16.9, 17 3	1 34 2 W			14 3, 15 2	38016	2		C II
			Jun 17, 11			10 8, 11 4	4 36 6 S				EI 2	C II
			Jun 17, 11			12 3	4 37.7 S				EI 2	C II
			Jun 19, 11	10 0, 10.3	1 36.8 W	12 5, 13 2	4 35 4 S			2	201 12	C II
			Jun 19, 11	10.4, 10.7	1 37.0 W	13 8, 14 5	4 35 7 S			2	201.12	C II
			Jun 26, 11	11 6, 14 5	1 36 4 W	13 0	4 39 0 S			14	14 56	LAB
			Jun 27, 11	9 8, 11 2	1 35 6 W			10 5, 13 2	38039	2		C II
			Jun 27, 11	12.6, 13.9	1 37.4 W					2		C II
			Jun 27, 11	14.5, 16 0	1 36 8 W			15 2	37971	14		LAB
			Jun 29, 11			11 0, 11 8	4 37 0 S				EI 2	C II
			Jun 29, 11			12 2, 12 7	4 37 3 S				EI 2	C II
			Jun 29, 11			13 1, 15.3	4 38 2 S				EI 2	C II
			Jun 29, 11			16 1, 17 0	4 39 0 S				EI 2	C II
			Jun 29, 11			17 5	4 39 3 S				EI 2	C II
Colombo, *B*	6 54 2 N	79 52	Jun 16, 11	8.2, 9 8, 10.1	1 30 8 W			8 6, 9 5	38202	4		C II
			Jun 16, 11	13.6, 13.8, 15 6	1 32.6 W			10 4, 13 2	38198	4		C II
			Jun 16, 11					14 2, 15.2	38184	4		C II
			Jun 19, 11			12 1, 12 6	4 35 0 S				EI 2	C II
			Jun 19, 11			13 5, 14.0	4 35 4 S				EI 2	C II
			Jun 19, 11			14 8	4 36 7 S				EI 2	C II
			Jun 20, 11			9.8, 10 6	4 33 6 S				EI 2	C II
			Jun 20, 11			11 3, 12.7	4 35 7 S				EI 2	C II
			Jun 20, 11			13 2, 14 0	4 36 8 S				EI 2	C II
			Jun 20, 11			14.8, 15 8	4 38 4 S				EI 2	C II
			Jun 21, 11			11 0, 11 8	4 36 6 S				EI 2	C II
			Jun 21, 11			12 2, 13 6	4 37 6 S				EI 2	C II
			Jun 21, 11			14 0, 14.6	4 37.5 S				EI 2	C II
			Jun 21, 11			15.1, 15 6	4 36 6 S				EI 2	C II
			Jun 27, 11	9.8, 11 2	1 32 6 W			10 5, 13 2	38250	14		LAB
			Jun 27, 11	12.6, 13 9	1 35 0 W					14		LAB
			Jun 27, 11	14 5, 16 0, 17 4	1 32.1 W			15 2, 16 9	38206	2		C II
			Jun 29, 11			15 7, 17 2	4 36 2 S				14 56	B&E
Colombo, *C*	6 54 2 N	79 52	Jun 13, 11	10 5, 14 3, 14 7	1 34 6 W			11 5, 13 8	37997	2		C II
			Jun 13, 11					15 3, 16 3	37999	2		C II
			Jun 14, 11	9.8, 10 0	1 35 6 W			10 7, 11.5	38052	2		C II
			Jun 14, 11	10 3, 11 9	1 35 8 W					2		C II
			Jun 14, 11	13 7, 16 6	1 35 6 W			14 4, 15 9	38000	4		C II
			Jun 15, 11	10 1, 12 5	1 36 2 W			10 8, 12 1	38020	4		C II
			Jun 15, 11	13.6, 15 8	1 35 2 W			14 1, 15 4	38026	4		C II

ISLANDS, INDIAN OCEAN.

JAVA.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Weltevreden (Batavia), *A*	6 11 0 S	106 50	Nov 1,'11			10 8, 11 5	31 17 0 S				EI 2	C II
			Nov 1, 11			15 2, 15 8	31 20 0 S				EI 2	C II
			Nov 1, 11			16 4, 17 0	31 20 4 S				EI 2	C II
			Nov 4, 11	8 7, 11 3, 14 3	0 41 6 E			9 3, 10 8	36700	4		C II
			Nov 4, 11	15 7, 17 0	0 41 7 E			14 8, 16 4	36702	4		C II
			Nov 10, 11	15 8, 16 1, 16 4	0 45 0 E					4		C II
Weltevreden (Batavia), *B*	6 11 0 S	106 50	Nov 2, 11			8 7, 9 6	31 19 0 S				EI 2	C II
			Nov 2, 11			10 2, 10 7	31 18 5 S				EI 2	C II
			Nov 2, 11			11 1, 12 0	31 18 2 S				EI 2	C II
			Nov 2, 11			12 6	31 18 0 S				EI 2	C II
			Nov 3, 11	7 3, 8 5, 8 9	0 42 3 E			7 8, 9 6	36738	4		C II
			Nov 3, 11	10 0, 10 3, 12 4	0 45.0 E			10 7, 12 1	36718	4		C II
			Nov 7, 11	7 1	0 45 7 E					4		C II
Weltevreden (Batavia), Pier *A*	6 11 0 S	106 50	Nov 7, 11					20 0, 21 4	36708	4		C II
			Nov 8, 11					20.5	36717	4		C II
Weltevreden (Batavia), Pier *C*	6 11 0 S	106 50	Oct 30, 11					19.7, 21 2	36735	4		C II
			Oct 31, 11					19 5, 20 6	36727	4		C II
Weltevreden (Batavia), Declination Pier	6 11 0 S	106 50	Nov 2, 11	20 9, 22 1	0 47 6 E					4		C II
			Nov 3, 11	20 4, 20 5	0 47 8 E					4		C II
			Nov 3, 11	20 9, 21 1	0 47 0 E					4		C II
Weltevreden (Batavia), Earth-Inductor Pier	6 11 0 S	106 50	Nov 4, 11			21 4, 22 1	31 19 5 S				EI 2	C II
			Nov 10, 11			19 4, 19 9	31 20 0 S				EI 2	C II
			Nov 13, 11			21 0, 21 6	31 21 2 S				EI 2	C II
			Nov 13, 11			23 6, 24 1	31 20 1 S				EI 2	C II

MAURITIUS

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T.	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Pamplemousses, *A**	20 05 6 S	57 34	Aug 12,'11	8 8, 11 8, 12 3	9 23 9 W			9.5, 10 2	23317	4		C II
			Aug 12, 11					10 8, 11 4	23318	4		C II
Pamplemousses, *B**	20 05 6 S	57 34	Aug 8, 11	14 9, 16 5	8 38 5 W			15 7	.23129	4		C II
			Aug 9, 11	8 9, 10 0	8 42.8 W			9 6, 10 9	23143	4		C II
			Aug 9, 11	10 4, 11 4	8 45 0 W					4		C II
			Aug 10, 11	9 2	8 41 3 W			9 8, 10 3	23148	4		C II
			Aug 14, 11			10 6, 11 0	54 27 6 S				EI 2	C II
			Aug 14, 11			11 6, 12 2	54 27 8 S				EI 2	C II
			Aug 14, 11			14 9, 15 4	54 26 9 S				EI 2	C II
			Aug 14, 11			16 3, 17 0	54 27 7 S				EI 2	C II
			Aug 15, 11			7 6, 8 2	54 27 2 S				EI 2	C II
			Aug 15, 11			9 6, 10 1	54 27 4 S				EI 2	C II
			Aug 15, 11			10 6, 11 1	54 27 0 S				EI 2	C II
			Aug 15, 11			11 4, 12 5	54 26.7 S				EI 2	C II
			Aug 15, 11			12 9, 13.3	54 27 0 S				EI 2	C II
			Aug 15, 11			15 1, 15.8	54 27.0 S				EI 2	C II
Pamplemousses, *C**.	20 05 6 S	57 34	Aug 9, 11	14 5, 16 3, 16 5	9 49 9 W			15 1, 15 9	23530	4		C II
			Aug 9, 11					16 9	23522	4		C II
			Aug 10, 11					11.3, 12 0	23528	4		C II
			Aug 10, 11					15 7	23519	4		C II
Pamplemousses, *D**	20 05 6 S	57 34	Aug 11, 11			9 4, 10 0	53 24 8 S				EI 2	C II
			Aug 11, 11			10.5, 11 1	53 24 5 S				EI 2	C II
			Aug 11, 11			11 5, 11 9	53 23 9 S				EI 2	C II
			Aug 11, 11			14 7, 15 2	53 22 7 S				EI 2	C II
			Aug 11, 11			15 7, 15 9	53 23 3 S				EI 2	C II
			Aug 12, 11			14 8, 15 2	53 22 2 S				EI 2	C II
			Aug 12, 11			15 6, 15 9	53 23 4 S				EI 2	C II

*Local disturbance

ISLANDS, PACIFIC OCEAN.

FIJI ISLANDS.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Suva Vou, *A*	18 07 1 S	178 25	Jun 13,'12	10.3, 12 8	10 22 8 E			10 8, 12 2	34734	4		C II
			Jun 13, 12	13 9, 16 1	10 24 6 E			14 3, 15 5	34705	4		C II
			Jun 14, 12	10 6, 13 8	10 22 9 E			11 3, 13 4	34731	2		C II
			Jun 14, 12	14.2, 16 0	10 23.6 E			14 6, 15 5	34708	2		C II
			Jun 19, 12			10 3, 11 0	38 27 8 S				EI 2	C II
			Jun 19, 12			11 5, 12 0	38 28 4 S				EI 2	C II
			Jun 19, 12			13 4, 14 3	38 28 0 S				EI 2	C II
			Jun 19, 12			15 0, 15 6	38 27 9 S				EI 2	C II
Suva Vou, *B*	18 07 1 S	178 25	Jun 11, 12	14 6, 16 4	10 26 5 E			15 3	34652	2		C II
			Jun 12, 12	10 7, 12 0, 12 9	10 23 7 E			11 2, 13 4	34677	2		C II
			Jun 12, 12	14 3, 15 7	10 26 2 E			15 0	34669	2		C II
			Jun 12, 12	16 0, 17 1	10 26.4 E					2		C II
			Jun 13, 12	10 3, 12.8	10 25.0 E			10 8, 12 3	34672	2		C II
			Jun 13, 12	13.9, 16 1	10 25 4 E			14 4, 15 6	34654	2		C II
			Jun 14, 12	10 6, 13.8	10 24.8 E			11 3, 13 3	34666	4		C II
			Jun 14, 12	14 2, 16.0	10 24 8 E			14 6, 15 5	34683	4		C II
			Jun 15, 12	10 3, 10.6, 10 9	10 24 2 E					4		C II
			Jun 15, 12	11 2, 11 9	10 24.2 E					4		C II
			Jun 17, 12			13 0, 13 4	38 28 8 S				EI 2	C II
			Jun 17, 12			13 9, 14 3	38 28 8 S				EI 2	C II
			Jun 17, 12			14 7, 15 1	38 28 6 S				EI 2	C II
			Jun 17, 12			15 6	38 28 7 S				EI 2	C II
			Jun 18, 12			10.1, 10 6	38 27.6 S				EI 2	C II
			Jun 18, 12			11 1, 11 8	38 28 0 S				EI 2	C II
			Jun 18, 12			14 6, 15.1	38 28 8 S				EI 2	C II

MACQUARIE ISLAND.[1]

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
North End Settlement, *A*	54 30 7 S	158 57	Dec 13,'11	9 2, 11.7	18 33.8 E	14 4	77 50 0 S	10 0, 11 2	.13986	9	178 12	W&K
North End Settlement, *B*	54 30.7 S	158 57	Dec 15, 11	10 4, 10.7	18 07.8 E					*169*		ENW
North End Settlement, *C*	54 30.7 S	158 57	Dec 16, 11	11 8, 12.2	18 24 9 E					*169*		ALK
North End Settlement, *D*	54 30 7 S	158 57	Dec 18, 11	12.6	18 25 6 E					*169*		ENW
Caroline Cove	54 46 5 S	158 47	Dec 11, 11	13.0	16 30.7 E	15.2	77 56 4 S	13 6	13578	9	178 12	ENW

PHILIPPINE ISLANDS.

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Antipolo, *A*	14 35 9 N	121 11	Feb 14,'12			8 6 9.0	16 17 7 N				EI 2	C II
			Feb 14, 12			9 5, 10 0	16 16 8 N				EI 2	C II
			Feb 14, 12			11.0, 11 6	16 15 8 N				EI 2	C II
			Feb 14, 12			12 0, 14 1	16 16 7 N				EI 2	C II
			Feb 14, 12			14 6, 14 9	16 17.5 N				EI 2	C II
			Feb 14, 12			15 3, 15 6	16 18 0 N				EI 2	C II
			Feb 17, 12	9 2	0 38 7 E			9 9	38211	4		C II
			Feb 19, 12	14 1, 16 2	0 39 4 E			14 7, 15 8	38203	4		C II
			Feb 19, 12	17 6, 17 8	0 39 8 E					4		C II
			Feb 20, 12	9 0, 10 5	0 38.6 E			9 6	38225	4		C II
			Feb 20, 12	11 0, 11 3	0 37 9 E					4		C II
Antipolo, *B*	14 35.9 N	121 11	Feb 8, 12	14 8, 16.3	0 43 4 E			15 5	38193	4		C II
			Feb 9, 12	9.8, 11.0, 11 3	0 40 9 E			10 3, 11 9	38218	4		C II
			Feb 9, 12	13 8, 15.2	0 42 2 E			14 6	38183	4		C II
			Feb 10, 12	7.3, 7 8	0 42 9 E					4		C II
			Feb 15, 12			14 3, 15 0	16 08 6 N				EI 2	C II
			Feb 15, 12			15 4, 16 1	16 08 9 N				EI 2	C II
			Feb 15, 12			16 6, 17 1	16 08 9 N				EI 2	C II
			Feb 16, 12			8 9, 10 4	16 07 8 N				EI 2	C II
			Feb 20, 12	12 0, 14 2, 14 4	0 41 4 E	16 2, 17 0	16 09 3 N			4	EI 2	C II
			Feb 20, 12			17 7	16 10 5 N				EI 2	C II
			Feb 22, 12	6 8, 7 0, 7 3	0 41 8 E					4		C II
			Feb 22, 12	7 6, 7 9, 8 1	0 41.5 E					4		C II
Antipolo, *C*	14 35.9 N	121 11	Feb 10, 12	9 0, 10 5, 11 8	0 39.5 E			9 7	38227	4		C II
			Feb 10, 12					11.3, 12 2	.38220	4		C II
			Feb 12, 12	11 7, 12 1, 14.6	0 39.3 E			14 1	38224	4		C II
			Feb 13, 12			11 0, 11 8	16 11 2 N				EI 2	C II
			Feb 13, 12			14 3, 15 0	16 12 6 N				EI 2	C II

[1] These observations were obtained by the Australasian Antarctic Expedition in cooperation with the Department of Terrestrial Magnetism, the latter organization furnished the magnetic outfits, trained the observers, determined the instrumental constants before and after the field work, and made the final reduction of the observations.

ISLANDS, PACIFIC OCEAN.

PHILIPPINE ISLANDS—*Concluded*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Antipolo, *C*—*Continued*	14 35 9 N	121 11	Feb 13,'12			15 6, 16 0	16 13 0 N				EI 2	C II
			Feb 13, 12			16 5	16 13 8 N				EI 2	C II
			Feb 22, 12	10 6, 10 9, 11 1	0 38 9 E					4		C II
SAMOAN ISLANDS.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Apia	13 48 4 S	188 14	May 5,'11	14 2, 16 1	9 46 6 E	16 8	29 42 8 S	15 5	35551	14	14 56	LAB
			May 6, 11	10 5, 12 0, 16 0	9 44 4 E	12 6	29 37 0 S	11 4, 15 9	35510	14	14 56	LAB
Tau, *A*	14 13 S	190 27	Apr 27, 11	17 3	8 59 E					9		LAB
Tau, *B*	14 13 S	190 27	Apr 27, 11			16 6	30 34 8 S				14 56	LAB
Pago Pago*	14 17 2 S	189 19	May 2, 11	11 2	10 19 8 E	12 1	29 32 9 S	13 4	*35818*	*14*	14.56	LAB
SOCIETY ISLANDS.												
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Papeete*	17 31 8 S	210 27	Sep 27,'12			14 8	30 00 7 S				201.125	C II
			Sep 28, 12	9 8, 11 6	8 21 5 E			10 4, 11 2	33448	4		C II
Small Coral Island (Papeete Harbor), *A**	17 33 0 S	210 25	Sep 20, 12			10 2, 11 0	29 39 3 S				EI 2	C II
			Sep 20, 12			12 6, 13 1	29 37 6 S				EI 2	C II
			Sep 20, 12			13 8, 14 5	29 37 3 S				EI 2	C II
			Sep 20, 12			15 1	29 38 0 S				EI 2	C II
			Sep 23, 12	9 0, 10 6, 10 8	9 58 6 E			9 8, 11 4	33834	2		C II
			Sep 23, 12	12 1, 13 3, 14 5	10 01 5 E			13 9	.33810	2		C II
			Sep 23, 12	16 6, 17 8	10 02 4 E					2		C II
			Sep 24, 12	9 6, 11 6, 12 8	9 58 9 E			10 1, 11 3	33831	4		C II
			Sep 24, 12	14 5, 15 1, 16 6	9 59 8 E			13 2, 14 1	33809	4		C II
			Sep 24, 12					15 5, 16 3	33820	4		C II
			Sep 25, 12	9 4, 11 2, 11 4	9 57 7 E			9 8, 10 8	33821	2		C II
			Sep 25, 12	13 6, 13 8, 15 6	10 00 6 E			11 7, 13 2	33800	2		C II
			Sep 25, 12					14 2, 15 2	33808	2		C II
			Oct 3, 12	9 3, 11 4, 12 2	9 58 1 E			9 9, 10 9	33854	19		C II
			Oct 3, 12	13 6, 13 9, 15 3	10 00 8 E			12 6, 13 3	33857	19		C II
			Oct 3, 12					14 2, 14 9	33854	19		C II
			Oct 4, 12			11 0, 11.6	29 36 4 S				EI 2	C II
			Oct 4, 12			13 3, 13 7	29 36 9 S				EI 2	C II
			Oct 4, 12			14 7, 15 4	29 38 0 S				EI 2	C II
			Oct 4, 12			16 0	29 38 8 S				EI 2	C II
			Oct 10, 12	0 5	9 58 7 E					19		C II
			Oct 10, 12	1 0 to 6 0(dv)	9 59 3 E					19		C II
			Oct 10, 12	6 1	9 59 2 E					19		C II
Small Coral Island (Papeete Harbor), *B**	17 33 0 S	210 25	Sep 19, 12			10 6, 11 2	29 38 9 S				EI 2	C II
			Sep 19, 12			11 6, 12 8	29 37 7 S				EI 2	C II
			Sep 19, 12			14.1, 14.6	29 36 6 S				EI 2	C II
			Sep 19, 12			15 4, 16 0	29 37 3 S				EI 2	C II
			Sep 21, 12	9.7, 11 1, 11 3	10 01 1 E			10 3, 12 5	33890	2		C II
			Sep 21, 12	13 2, 13 4, 14 9	10 04 6 E			14.1	33863	2		C II
			Sep 24, 12	9 6, 11 6, 12 8	10 05 0 E			10 1, 11 3	33858	2		C II
			Sep 24, 12	14 5, 15 1, 16 6	10 06 4 E			13 2, 14 2	33840	2		C II
			Sep 24, 12					15 5, 16 3	33850	2		C II
			Sep 25, 12	9 4, 11 2, 11 4	10 02 3 E			9 9, 10 8	33892	4		C II
			Sep 25, 12	13 6, 13 8, 15 6	10 04.3 E			11 7, 13 2	.33880	4		C II
			Sep 25, 12	16 3, 17 6	10 04 1 E					2		C II
			Sep 25, 12					14 1, 15 2	33876	4		C II
			Sep 26, 12	9 3, 10 8	10 01 7 E					2		C II
			Oct 3, 12	9 3, 11 4, 12 2	10 01 8 E			9 8, 11 0	33901	4		C II
			Oct 3, 12	13 6, 13 9, 15 3	10 04 9 E			12 5, 13 3	33918	4		C II
			Oct 3, 12					14 2, 15 0	33898	4		C II
			Oct 5, 12			9 9, 10.5	29 37 6 S				EI 2	C II
			Oct 5, 12			11 0, 11 4	29 36.8 S				EI 2	C II
			Oct 5, 12			11 8, 13 2	29 36 9 S				EI 2	C II
			Oct 5, 12			13 5, 14 2	29 37 2 S				EI 2	C II
			Oct 5, 12			14 5, 15 0	29 37 6 S				EI 2	C II
			Oct 5, 12			15 5	29 38 2 S				EI 2	C II

*Local disturbance

ANTARCTIC REGIONS.[1]

VICTORIA QUADRANT

Station	Latitude	Long East of Gr.	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M. T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Australasian Antarctic Expedition Base 2 (Igloo)	66 19 9 S	95 01	Jun 13,'12	14 9, 22.2	66 01 9 W					6		ALK
			Jun 16, 12	0 2	66 00 9 W					6		ALK
			Jun 17, 12	21 1	66 03 3 W					6		ALK
			Jun 29, 12			17 9	77 52 1 S				169 56	ALK
			Jul 2, 12	21 2	65 58 5 W					6		ALK
			Jul 4, 12					21 2	12692	6		ALK
			Aug 2, 12	15 7	65 56 3 W			16 0	12956	6		ALK
			Aug 5, 12	12 3, 16 5	66 00 2 W			13 5, 15 6	12932	6		ALK
			Aug 6, 12	15 6	66 19 1 W	16 7	77 57.4 S			*169*	169 5	ALK
			Aug 7, 12	15 8, 16 2	65 54 6 W	21 1	77 56 3 S			*169*	169 56	ALK
			Aug 8, 12			16 2	78 04 1 S				169 56	ALK
			Aug 13, 12	14 4	65 59 2 W					6		ALK
			Aug 30, 12	13 2	65 56 6 W					*169*		ALK
			Aug 31, 12	13 8	66 03 7 W	14.0	77 54 3 S			*169*	169 56	ALK
			Sep 3, 12	21 8	65 59 6 W					6		ALK
Australasian Antarctic Expedition Base 2 (Tent) ..	66 19 9 S	95 01	Jan 21, 13	16 4	65 55 7 W					6		ALK
			Jan 22, 13	12 9, 17 7	66 03 2 W			15 4, 17 0	12957	6		ALK
			Jan 24, 13	11 6, 15 2	65 56 9 W			11 8	12954	6		ALK
			Jan 27, 13	11 9, 12 1	66 08 7 W					6		ALK
			Jan 28, 13	10 7	66 08 8 W			11 5	12908	6		ALK
			Jan 30, 13	10 8	66 06 0 W			11 6, 14 6	12960	6		ALK
Commonwealth Bay, *C*.	67 00 0 S	142 36	Jan 18, 12	16 5	4 41 5 E					9		ENW
Commonwealth Bay, *A* .	67 00 2 S	142 37	Feb 20, 12	15 1	6 26 7 W			16 1	03073	9		ENW
			Mar 14, 12					14 7, 17 1	.03105	9		ENW
			Mar 28, 12			18 1	87 22 9 S	23 5	*03098*	*178*	178 12	ENW
			Apr 1, 12	12 3, 15 1	6 20 2 W			16 5, 18 2	03126	9		ENW
			Apr 6, 12	15 8	6 06 2 W			17 1	03118	9		ENW
			Apr 9, 12			17 8	87 21 4 S	19 6	*03106*	*178*	178 12	ENW
			Apr 13, 12	16 9, 17 3	5 48 7 W			18 0, 19 3	03058	9		ENW
			Apr 17, 12			7 4	87 19 8 S	7 6	*03129*	*178*	178 12	ENW
			Apr 20, 12	17.0	6 00 5 W			17 4, 17 7	03096	9		ENW
			Apr 21, 12					6 0	03108	9		ENW
			Apr 24, 12	15 4, 16 5	6 05 0 W			17 3, 19 1	03112	9		ENW
			Apr 29, 12	15 7	6 19 5 W	20 0	87 21 6 S	17 3	03121	9	178 12	ENW
			May 3, 12			16 0	87 22 0 S	16 2	*03120*	*178*	178 12	ENW
			May 4, 12	16 0	6 17 0 W					9		ENW
			May 7, 12	15 7	6 16 3 W					9		ENW
			May 9, 12	7 9	6 47 7 W			6 3	03115	9		ENW
			May 12, 12	15 5	5 27 7 W					9		ENW
			May 13, 12			6 9	87 21 6 S	7 2	*03124*	*178*	178 12	ENW
			May 16, 12	16 2	6 13 4 W					9		ENW
			May 18, 12					16 2, 17 4	03116	9		ENW
			May 21, 12	15 4	6 23 7 W					9		ENW
			May 24, 12			8 9	87 21 6 S	11 2	*03097*	*178*	178 12	ENW
			May 26, 12	14 5	6 20 3 W					9		ENW
			May 27, 12	14 6	6 18 6 W			15 4, 16 4	03120	9		ENW
			May 31, 12			21 0	87 21 5 S	21 4	*03090*	*178*	178 12	ENW
			May 31, 12	18 3	6 26 4 W					9		ENW
			Jun 7, 12	16 9	6 07 7 W	15 9	87 19 4 S			9	B 12	ENW
			Jun 8, 12					22 1	03133	9		ENW
			Jun 12, 12	18 6	6 16 8 W			16 2, 17 5	.03114	9		ENW
			Jun 13, 12			16 1	87 21 2 S	16 2	*03123*	*178*	178 12	ENW
			Jun 18, 12	18 8	6 21 8 W			16 6, 17 8	03112	9		ENW
			Jun 22, 12	17.7	6 31 0 W					9		ENW
			Jun 23, 12			18 4	87 21 9 S	18 5	*03098*	*178*	178 12	ENW
			Jun 28, 12	18 7	6 27 9 W			16 0, 17 4	03138	9		ENW
			Jul 2, 12	18 0	6 31 0 W					9		ENW
			Jul 3, 12			6 6	87 21 3 S	6 8	*03102*	*178*	178 12	ENW
			Jul 9, 12	7 1	6 18 8 W			5 9	03129	9		ENW
			Jul 10, 12	17 3	6 34 0 W			15 5, 16 4	03117	9		ENW
			Jul 14, 12	17 5	6 28 7 W					9		ENW
			Jul 15, 12			6 4	87 21 0 S	6 5	*03125*	*178*	178 12	ENW
			Jul 17, 12			15 9	87 21 5 S	16 1	*03105*	*178*	178 12	ENW
			Jul 20, 12					15 2, 16 5	03100	9		ENW

[1]These observations were obtained by the Australasian Antarctic Expedition in cooperation with the Department of Terrestrial Magnetism, the latter organization furnished the magnetic outfits, trained the observers, determined the instrumental constants before and after the field work, and made the final reduction of the observations.

ANTARCTIC REGIONS.

VICTORIA QUADRANT—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L M T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Commonwealth Bay, A —*Con*	67 00 2 S	142 37	Jul 21,'12	18 4	6 29 1 W		.	16 3, 17 2	03106	9		ENW
			Jul 26, 12	14 9	6 30 2 W	16 6	87 22 8 S			9	178 12	ENW
			Jul 26, 12					16 8	*03103*	*178*		ENW
			Jul 28, 12	17 1	6 35 2 W			15 0, 16 0	03102	9		ENW
			Aug 4, 12			15 9	87 21.9 S	16 1	*03102*	*178*	178.12	ENW
			Aug 6, 12	14 9, 15 6	6 49 4 W		.	16 2 .	02929	9		ENW
			Aug 7, 12	16 8	6 48 6 W	.		16 1	03094	9	.	ENW
			Aug 13, 12	14 6	6 27 6 W			15 4, 16 6	03108	9		ENW
			Aug 14, 12	7 6	6 58 5 W		.			9		ENW
			Aug 15, 12		.	16 3	87 21 4 S	16 4	*.03115*	*178*	178 12	ENW
			Aug 24, 12	.	.			15 7, 17 0	03078	9		ENW
			Aug 25, 12	15 2, 15 7	6 18 2 W					9		ENW
			Aug 26, 12			16 5	87 22 2 S	16 6	*03090*	*178*	178 12	ENW
			Aug 27, 12	15 7, 16 3	6 14 6 W				.	*178*		ENW
			Aug 29, 12	17 5	6 18 5 W					9		ENW
			Aug 30, 12	15 9	6 19 0 W					9		ENW
			Sep 2, 12	16 5	6 21 9 W					9		ENW
			Sep 3, 12	8 7 .	6 54 4 W	18 4, 18 7	87 21 6 S	6 9, 8 2	03126	9	178 1278	ENW
			Sep 3, 12		.			18 6	*03105*	*178*		ENW
			Sep 17, 12	16 1	6 13 0 W			16 7	03104	9		ENW
			Sep 18, 12	8 3	6 33 1 W	16 1	87 24 6 S	7 7	03085	9	178 1278	ENW
			Sep 18, 12				.	16 2 .	*03048*	*178*		ENW
			Sep 27, 12	17 8 .	6 26 6 W		.	19 0 .	03111	9		ENW
			Sep 28, 12	5 7	6 49 2 W		.	5 1 .	03117	9		ENW
			Sep 29, 12		.	2 9	87 21 7 S	3 0	*03106*	*178*	178 1278	ENW
			Oct 9, 12	18 9	6 02 1 W	22 0	87 21 4 S	5 7, 6 0	03109	9	178 1278	ENW
			Oct 9, 12	..			.	22 1 ..	*03099*	*178*		ENW
			Oct 16, 12	16.4	6 12 5 W			17 2, 19 0	03092	9		ENW
			Oct 18, 12	3 5	7 14 0 W					9		ENW
			Oct 21, 12	14 8 .	6 21 7 W	22 9	87 20 8 S	16 8 .	03104	9	178 1278	W&H
			Oct 21, 12					23 2	*03130*	*178*		ENW
			Oct 26, 12	16 4	5 54 6 W			17 1	03108	9		WHH
			Oct 28, 12	2 8, 5 9	6 53 8 W			3 2, 5 1	03126	9		ENW
			Oct 29, 12			22 5	87 21 4 S	22 6	*03103*	*178*	178 1278	ENW
			Oct 30, 12	15 9 .	6 19 2 W			17 9	03110	9		WHH
			Nov 4, 12	20 6	6 33 1 W			21 3	03148	9		WHH
			Nov 6, 12	.				6 4, 7 1	03086	9		ENW
			Nov 7, 12			2 7 .	87 20 6 S	2 8	*03120*	*178*	178 1278	ENW
			Nov 20, 12	20 7, 23 7	6 30 6 W			22 6	03109	9		WHH
			Nov 22, 12	0 6	6 24 7 W			1 5	03103	9		WHH
			Dec 1, 12	20 4	6 34 1 W		.	20 9	03108	9		WHH
			Dec 4, 12	19 4	6 27 0 W			20 0	03094	9		WHH
			Dec 11, 12	20 4 .	6 31 3 W			21 4	03090	9		WHH
			Dec 13, 12	0 7 .	6 19 8 W			1 7	03135	9	.	WHH
			Dec 22, 12	20 2 .	6 29 2 W		.			9	....	WHH
			Dec 29, 12	.		..	..	20 9	03196	9	. .	WHH
			Dec 31, 12	0 7	6 51 4 W	.				9	.	WHH
			Jan 5, 13	0 7	6 16 3 W	.				9	.	WHH
			Jan 7, 13	20 0 .	6 03 3 W	.	.	21 0	03096	9	..	WHH
			Jan 13, 13	23 1	6 41 5 W		...	23 9	03113	9	. .	WHH
			Jan 19, 13	21 0	4 40 1 W	.		21 7, 21 9	03127	9		ENW
			Jan 25, 13	17 4 .	5 40 6 W		. .	18 0	03101	9		W&B
			Jan 26, 13	17 2, 22 5	6 16 3 W		.	21 6	03109	9	. . .	W&B
Commonwealth Bay, *D*	67 00 2 S	142 37	Feb 5, 12			15 2	87 24 0 S	.			178 12	ENW
Commonwealth Bay, *B*	67 00 6 S	142 37	Aug 2, 12	15 6	1 22 4 W			16 3, 17 2	03071	9		ENW
			Aug 9, 12	15 2, 16 6	1 11 2 W	16 8	87 24 9 S			*178*	178 12	ENW
			Aug 12, 12	15 4	1 21 8 W	16 5	87 23 9 S	16 5	*03063*	*178*	178 123	ENW
Commonwealth Bay, *E*	67 08 8 S	142 37	Sep 14, 12	14 5	6 37 3 E	17 2	86 33 6 S			*178*	178 12	ENW
			Sep 15, 12			12 1 .	86 31 0 S	12 1	*04285*	*178*	178 3	ENW
Eastern Sledge Journey 1	67 19 0 S	144 13	Nov 21, 12	11 8, 17 3	21 0 W	15 2	87 51 6 S	.	.	Cary	B.1	CTM
Eastern Sledge Journey 2	67 23 8 S	144 39	Nov 25, 12	11 7 .	9 3 W					Cary	. .	CTM
Eastern Sledge Journey 3	67 24 4 S	145 47	Nov 28, 12	.		17 4	88 06 0 S	.			B 12	CTM
			Nov 29, 12	7 2 .	6 7 W			.	.	Cary	.	CTM
Eastern Sledge Journey 4	67 24 4 S	145 59	Nov 29, 12	11 7	7 8 W	.				Cary	.	CTM
Eastern Sledge Journey 13	67 24 5 S	144 36	Jan 6, 13	18 1	11 8 W	17 2	88 13 6 S			Cary	B 1	CTM
Southern Sledge Journey 1	67 26 6 S	142 44	Nov 17, 12	18 4	11 27 9 W			.		*178*		ENW
Eastern Sledge Journey 5	67 32 6 S	147 14	Dec 3, 12	8 2	3 2 E	10 6	87 43 9 S	.		Cary	B 12	CTM

ANTARCTIC REGIONS.

VICTORIA QUADRANT—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T	Value	L M T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	Γ			
Eastern Sledge Journey 12	67 36 0 S	146 02	Jan 1,'13	8 6	11 4 W	10.9	88 14 3 S			Cary	B 12	CTM
Eastern Sledge Journey 6	67 38 2 S	148 28	Dec 12, 12	8 2, 11 9	5 8 E	11 5	87 53 5 S			Cary	B 1	CTM
Eastern Sledge Journey 7	67 48.6 S	148 45	Dec 15, 12	8 0	4 9 W	. . .				Cary		CTM
Eastern Sledge Journey 8	67 51 2 S	148 46	Dec 15, 12			14 1	88 03 0 S			.	B 1	CTM
Southern Sledge Journey 2	67 56 5 S	142 55	Nov 21, 12	19 9 ..	40 26 3 W					*178*		ENW
Southern Sledge Journey 2A.	67 56 5 S	142 55	Nov 22, 12	. .	.	17 1	87 59 1 S	17 1	*02540*	*178*	178 123	ENW
Eastern Sledge Journey 9	68 18 9 S	150 24	Dec 19, 12	. .	..	11 3	88 17 0 S	.			B 12	CTM
Eastern Sledge Journey 10	68 19 9 S	150 13	Dec 19, 12	18 0 .	16 1 E				.	Cary	.	CTM
Southern Sledge Journey 3	68 20 1 S	143 45	Nov 28, 12	. .		17.4	88 52 8 S	17 5 .	*01353*	*178*	178.12378	ENW
			Nov 29, 12	12.8	29 18 5 E	.				*178*		ENW
Eastern Sledge Journey 11	68 21 5 S	149 54	Dec 20, 12	12 0 . .	15 2 E	. . .				Cary		CTM
Southern Sledge Journey 8	68 51 7 S	144 17	Dec 30, 12	19 7, 20 1	18 03 9 E	21 2	89 04 8 S	21 3	*01110*	*178*	178 12378	ENW
Southern Sledge Journey 4	69 12 8 S	144 53	Dec 7, 12		. .	18 7	89 08 5 S	18 8	*.01043*	*178*	178 12378	W,B,H
			Dec 8, 12	13 6 to								
			Dec 9, 12	15 6(dv)	33[1] W	. .	.	.	..	*178*		W,B,H
			Dec 9, 12	15 6 . .	31 W	.			.	*178*		W,B,H
Southern Sledge Journey 5.	69 33 5 S	145 19	Dec 27, 12	18 6	43 06 2 W	21.4	89 05 7 S	21 5	*01092*	*178*	178 12378	ENW
Southern Sledge Journey 6	70 02.7 S	146 43	Dec 17, 12	19 2 . ..	40 21 1 W	. .				*178*	.	ENW
			Dec 24, 12	15 8, 16 6 .	43 56 8 W[2]	16 8	89 24 9 S	16 9	*00693*	*178*	178 12378	ENW
Southern Sledge Journey 7	70 36 7 S	148 11	Dec 21, 12	16 2	50 30 4 W	16.2, 18 8	89 43 3 S	18 8	*00334*	*178*	178 12378	W&B

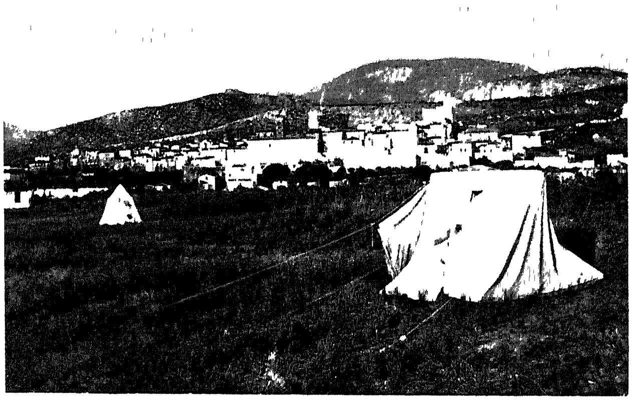
[1]From Dec. 8, 18^h (maximum) to Dec 9, 13^h (minimum) a range of 11° was observed by good settings on dip-circle compass Declinations were obtained from these settings by reference to declination of 31° W observed by sun compass at 15^h 6 on Dec 9

[2]Value at $15^h.8$, 46° 03′ 8 W, at 16^h 6, 41° 44′.8 W.

1

2

3



4

5

Typical Views of Magnetic Expeditions in Europe and Africa.

1. Near Observatory, Cape Town
2. Valetta, Malta.
3. Near Fort Motylinski, Algerian Sahara.
4 Comparison stations at Terracina, Italy
5 Tripoli, Tripoli

OBSERVERS' FIELD REPORTS.

The following reports, or extracts, will serve to give an idea of the conditions under which the various magnetic surveys, chiefly executed during the period January 1, 1911, to December 31, 1913, have been accomplished. The world-wide scope of the operations is shown by the list of countries in which magnetic observations were made during this period. For various reasons, the reports can not always be published in full as submitted by the observers; they frequently contain information of special concern only to the Department of Terrestrial Magnetism. Then again, as the observers write the reports themselves, they necessarily must minimize their own particular achievements. However, sufficient has been retained under each observer's report to give the reader ample opportunity to judge of the care, skill, courage, and thoroughness with which the work intrusted to the observer was executed. The reports are arranged alphabetically by observers' names.

J. P. Ault, on Magnetic Work in Peru, Bolivia, and Chile, March to August 1912.

In accordance with instructions of February 27 and March 21, 1912, I left Washington, D. C., for New Orleans on March 21, going by way of Baldwin, Kansas, in order to obtain from Observer C. C. Stewart information regarding conditions in South American countries. Arriving in New Orleans March 28 and being joined the following day by Messrs. Donald MacKenzie and H. R. Schmitt, who had been assigned as members of my party, we sailed March 30 from New Orleans on the United Fruit Company's steamship *Atenas*.

The following instrumental outfits were used by the party: J. P. Ault had universal magnetometer No. 14 (with dip needles Nos. 1, 2, 5, and 6, and intensity needles Nos. 3, 4, 7, and 8), chronometer No. 677 and watch No. 100, and observing-tent No. 23 provided with sod-cloth; Donald MacKenzie used magnetometer No. 16, dip circle No. 177 (with dip needles Nos. 1, 2, 5, and 6 and intensity needles Nos. 3 and 4), pocket-chronometer Kittel No. 257, and watches Nos. 804 and 811 in leather belt, and observing-tent No. 21 with sod-cloth and hammock; H. R. Schmitt had magnetometer No. 8, dip circle No. 171 (with dip needles Nos. 171.1, 171.2, 177.7, 177.8, and intensity needles Nos. 171.3 and 171.4), chronometer No. 1044 and watch No. 53, and observing-tent No. 24 with sod-cloth and hammock.

Upon arrival at Colon, Panama, on April 4, our magnetic station was reoccupied on that day. The party sailed from Balboa for Callao on the Pacific Steam Navigation Company's steamship *Guatemala* on April 8, arriving at Callao and Lima, Peru, on April 15. After two weeks spent in preliminary arrangements, instructions, and practice, Mr. MacKenzie left Lima on May 28 for Antofagasta and La Paz. After arriving at the latter place on May 25, having established 3 complete and 2 incomplete stations, he resigned and returned to his home. In the meanwhile arrangements were being made for the trip to Masisea on the Ucayali River, and instructions and practice were given to Mr. Schmitt. I was planning to make this trip myself, but, upon receipt of cabled advice from the Director, the plans were changed and Mr. Schmitt was sent instead on May 20, while I accompanied him as far as Tarma. Upon arrival at La Merced on May 26 he found that chronometer No. 677 had stopped. He was instructed to return to Oroya, where I delivered to him on May 31 chronometer No. 1044. For an account of Mr. Schmitt's trip, see his separate report.

In accordance with cabled instructions received after my return from Oroya, I left Lima on June 10 and arrived at La Paz on June 15 and took charge of Mr. MacKenzie's

outfit and affairs. During the period June 19 to July 10, according to my instructions, I occupied 7 stations on the railway lines of Bolivia, leaving La Paz on July 15 for Arequipa and Mollendo, where I met Mr. A. D. Power on July 19, who was assigned to my party in Mr. MacKenzie's place. From July 20 to 31, Mr. Power was given general instruction and practice in the work to be undertaken by him, a station being established at the Arequipa branch of the Harvard Astronomical Observatory. On August 1 we proceeded to Mollendo and thence to Chala, at both of which places magnetic stations were established. From Chala I proceeded to Lima, arriving August 8, leaving Mr. Power to continue the work which had been assigned to him in Peru. The reader is referred to Mr. Power's own report of his work.

In Lima I was busy concluding the affairs of the campaign, making arrangements for Mr. Schmitt's trip from Huancayo to Cuzco, and with matters concerning the continuation of Mr. Power's work up the coast of Peru, to whom final suggestions and instructions were given after his arrival at Lima, August 15. On August 16 I proceeded to Oroya, where I met Mr. Schmitt upon his return from Masisea, and concluded all the financial obligations incurred. After completing all arrangements for the continuation of the work in Peru, I sailed for New York on August 20, arriving at Washington, D. C., on September 3.

Table 6 is a synopsis of the work accomplished by the party.

TABLE 6

No.	Station occupied	Date	Observer	Remarks
		1912		
1	Colon, Panama	Apr. 4	J. P. A., D. M., H. R. S.	C. I. W. repeat station.
2	Lima, Peru	Various, Apr. 20 to Aug. 19.	J. P. A., D. M., H. R. S.	Friesach observed here in 1858
3	San Lorenzo Island, Peru	May 1	J. P. A., H. R. S.	C. I. W. repeat station.
4	Antofagasta, Chile	May 7, 8	D. M.	
5	Calama, Chile	May 12	D. M.	
6	Cebollar, Chile	May 15, 16	D. M.	
7	Uyuni, Bolivia	May 18	D. M.	
8	Oroya, Peru	May 21	J. P. A., H. R. S.	
9	Oruro, Bolivia	May 22	D. M.	
10	Tarma, Peru	May 23	H. R. S., J. P. A.	
11	La Merced, Peru	May 27, June 4	H. R. S.	
12	Eneñas, Peru	June 9, 10, Aug. 11	H. R. S.	
13	San Nicolas, Peru	June 14, 15	H. R. S.	
14	La Paz, Bolivia	June 19, July 11	J. P. A.	Friesach observed here in 1860.
15	Puerto Bermudez, Peru	June 21, 22, Aug. 4	H. R. S.	
16	Uyuni, Bolivia	June 23	J. P. A.	C. I. W. repeat station.
17	Challapata, Bolivia	June 24	J. P. A.	
18	Rio Mulato, Bolivia	June 26	J. P. A.	
19	Puerto Victoria, Peru	June 26	H. R. S.	
20	Potosi, Bolivia	June 28	J. P. A.	
21	Platanos, Peru	June 30	H. R. S.	
22	Huarnonia, Bolivia	July 4	J. P. A.	
23	Baños, Peru	July 5	H. R. S.	
24	Honoria, Peru	July 7	H. R. S.	
25	Patacamaya, Bolivia	July 8, 9	J. P. A.	
26	Masisea, Peru	July 20, 21, 22	H. R. S.	C. I. W. repeat station.
27	Arequipa, Peru	July 22, 27	J. P. A., A. D. P.	Friesach observed here some time between 1855 and 1860

The distances traveled may be summarized as follows:

TABLE 7.

	J. P. A.	D. M.	H. R. S.	Entire party
	miles	*miles*	*miles*	*miles*
Travel to and from field	10,620	4,665	3,980	19,265
Travel in field	980	700	1,000	2,680
Total travel	11,600	5,365	4,980	21,945

This gives an average total travel of 813 miles per station and an average field travel of 99 miles per station. Owing to the delays and difficulties of transportation, it required on the average 5 days per station.

Judging from the results of Mr. Schmitt's trip to Masisea the region traversed was highly disturbed, while the region covered in Bolivia should be fairly normal, the stations being at some distance from the main ranges of the Andes, with the exception of Potosi and Huarnonia. Highly magnetic black sand was found at Mollendo intermixed with common sand of the coast.

The officials of Peru were very courteous and did everything possible to facilitate the work of the expedition. The official through whom all the negotiations were conducted was Sr. G. Cisneros y Raygada, Introductor de Ministros, Ayacucho 428, Lima, Peru, who showed in various ways his interest in the object of the expedition.

D. W. BERKY, ON MAGNETIC WORK IN MOROCCO, GAMBIA, SIERRA LEONE, AND FRENCH GUINEA, MARCH TO AUGUST 1912.

In pursuance of instructions of March 13, 1912, I left New York March 17, 1912, and arrived at Gibraltar March 27, where I joined my chief of party, Mr. W. H. Sligh, for instruction in field work and definite assignment of duty. As equipment I carried the following: magnetometer No. 13; dip circle No. 223, needles 1, 3, 5, 6; pocket chronometer No. 260; Howard watch No. 820; observing-tent No. 17, with a lot of miscellaneous equipment.

On March 28 Mr. Sligh and I proceeded to Tangier, Morocco. Here, in the interval between March 28 and April 5, a caravan expedition across northwest Morocco via Fez and Rabat was decided on by Mr. Sligh. On April 5–6 a station was occupied at Tangier by Mr. Sligh, also a practice station by myself. Mr. Sligh considered it advisable to return to Gibraltar to equip for the caravan trip to Fez. On April 9 we returned to Gibraltar. On April 10, leaving Mr. Sligh to finish the equipping, I proceeded to San Roque, Spain, to reoccupy Mr. Sligh's station there for practice work.

On April 20, having rejoined Mr. Sligh, we returned to Tangier. Arriving there it was found necessary to abandon the caravan trip to Fez and Rabat because a revolt had occurred at Fez and about 300 Europeans had been massacred. Changing plans at once, Mr. Sligh decided to establish stations at the Moorish ports open to steamers. Rough weather, rendering the bar in the Tangier harbor impassable, kept us prisoners till May 1, when we left Tangier by steamer, arriving at Laraish on May 2. Here 2 stations were occupied the next day, and Mr. Sligh assigned me the task of establishing stations at Rabat, Mazagan, Saffi, and Mogador, leaving instructions to rejoin him at the Canary Islands, where he went to charter a sailing-vessel to establish stations on the Saharan coast.

By traveling on a cargo-boat, and using her delays to discharge and embark cargo, the assignment of stations as above noted was completed without loss of time. Mogador was reached on May 22; here, on account of plague, I was held in quarantine to May 30. Las Palmas, Canary Islands, was reached on June 1. Rejoining Mr. Sligh, I received instructions from him to take up work on the west coast of Africa, south of Dakar, and to occupy as many stations as conditions of travel permitted. Thereafter I was to meet him again at Algiers about September 1. There were thus established the following magnetic stations on the west coast of Africa:

1. Bathurst, Gambia, 2 stations.	4. Bo.	7. Kindia.
2. Freetown, Sierra Leone.	5 Baiima	8. Mamou
3. Moyamba	6. Conakry.	

Leaving Mamou on August 16, I took a steamer at Conakry August 19, and traveling via Boulogne and Marseille, arrived at Algiers on September 2. For an account of my work thereafter, see the report on the trans-Saharan expedition.

After June 22, the work in Sierra Leone and French Guinea was greatly retarded by the rainy season and every station occupied required double or triple expenditure of energy. The station at Freetown, Sierra Leone, was practically a reoccupation of the station of 1912 by Observer Johnston. A new station within about 100 yards was also established; the results indicate local disturbance at the old station.

Regarding the time consumed in establishing the above-named stations, it is necessary to make the explanation that the traveler in the undeveloped or semi-developed regions of Africa is not master of his time, but must with patience await the outcome of many unforeseen incidents. Some of the ports have bar harbors and a landing is impossible in rough weather. Quarantine is encountered. Unsettled conditions may cause complete change of plans at the last instant. Physical features also may cause great delay, especially during the rainy season.

Magnetic conditions.—Conakry is reputed amongst navigators and local people interested in such matters as very much disturbed magnetically. Throughout Gambia, French Guinea, and Sierra Leone, there is much rock of a ferrous nature, red in color. In French Guinea this rock approaches the surface so closely that over large areas the soil is wanting entirely, or, is so shallow as to support but very scant vegetation.

Throughout the trip every assistance and courtesy was extended by the officials of the countries visited. It is a pleasure also to make mention of numerous courtesies and kindnesses extended by many people whose acquaintance was made in the course of the work.

D. W. Berky, on Trans-Saharan Magnetic Expedition from Algiers, Algeria, to Timbuktu, French West Africa, October 1912 to July 1913.

In pursuance of the Director's instructions of March 13, 1912, I left Conakry, in French Guinea, Africa, August 18, and traveling with all expedition via Boulogne, Paris, and Marseille, arrived at Algiers on September 2, 1912. Here I rejoined my chief of party, Mr. Sligh, and assisted him in the final organization of the trans-Saharan expedition, of which I was to have charge when Mr. Sligh returned to Washington.

As mentioned in Mr. Sligh's report, we were fortunate to make the acquaintance at Algiers of Commandant O. Meynier, officer of the French Colonial Staff, who, in 1899-1900, after the loss of Captain Voulet, had been associated with Lieutenant Joalland, commanding a French military expedition of conquest which was operating from the West African coast toward Zinder and Lake Tchad. The route of the expedition lay largely in the desert regions of southern Sahara. It is to be noted in this connection that this expedition was only part of a much larger scheme of French occupation and was operating simultaneously with the Foureau-Lamy Expedition, penetrating Africa from Algeria. The latter was the first successful trans-Saharan expedition, and after crossing the Sahara, united with the expedition of Joalland-Meynier and assisted in the conquest of territory in the vicinity of Lake Tchad. Thus thoroughly conversant with conditions in the Sahara in Southern Algeria, and well acquainted by active military service with the regions in South Sahara, Commandant Meynier was well qualified to give information about conditions to be met and to advise as to the equipment of a party contemplating crossing the Sahara. It was a source of congratulation, indeed, that this acquaintance was made and that he gave to the organizing and equipping of our own expedition his unreserved and enthusiastic assistance.

Observer H. E. Sawyer, who had been assigned to the party, arrived in Algiers on September 29. Our preparations were interrupted for a few days in order to make special declination observations at the Bouzareah Observatory on the occasion of the solar eclipse on October 10. On account of the serious nature and expected duration of the projected work, the preparations were of necessity painstaking and tedious. Time was also consumed in obtaining certain required equipment from Paris, as well as by the fact that certain articles of equipment had to be made at Algiers under our supervision. The suggestions of the

French military authorities were followed, except where modification seemed necessary on account of the nature of our work.

Preparations having neared completion at Algiers, I went on October 20 to the railway terminus at Biskra. This was to be the point of departure of our first caravan, and it was my duty to make final preparations. In the meanwhile preparations at Algiers were completed by Mr. Sligh, assisted by Mr. Sawyer, who was to join me at Biskra with the rest of the equipment, so that a start could be made without delay.

It was deemed advisable to carry sufficient provisions to last the expedition for 7 months. As the party was to consist of 3 white men, these provisions, though limited to essentials, made a considerable item of our luggage, the total of which was estimated at about 4,000 pounds. To transport this and ourselves, a caravan of about 20 camels would be required. Such a caravan I proceeded to engage as soon as possible after my arrival at Biskra. Through a military contractor a caravan of 19 camels was finally engaged. Three army mules were to be furnished for transporting the 2 American magnetic observers and a Maltese interpreter of Arabic and French. On the advice of Captain Chenin, of the Bureau Arabe of Biskra, 3 men were engaged to join the party as servants. One of these was to act as cook and two of them were to act as personal servants and to assist in camp-duties. These men were vouched for by Captain Chenin. One of them, the cook, an elderly, black Arab, had been to Timbuktu with a previous French expedition. The other two were brothers, Josef ben Saad and Isa ben Saad, professional guides. I had every confidence in the judgment of Captain Chenin, as he had seen hard service in the Sahara, had been severely wounded, and was an officer of the Légion d'Honneur. This confidence was amply justified in the services rendered throughout the long route to Timbuktu by the two brothers, Josef and Isa.

The expedition left Biskra on October 29, 1912, under my charge. The personnel of the first caravan was made up as follows: 2 American magnetic observers, 1 European interpreter, 1 Arab cook, 2 Arab servants, 2 soldiers (courteously provided by the military authorities), 6 caravaneers, 3 muleteers, making a total of 17 men; 19 camels for transport of provisions, and 3 mules, hence a total of 22 animals. The more important items of special equipment were 3 living tents, with sleeping outfit for each, a cooking outfit and field medical outfit. Each white member of the party was armed with a Winchester rifle and a revolver; for each weapon 500 rounds of ammunition were carried. The 3 Arab servants of the party were armed with shotguns. The chief of the caravan was similarly armed. The arms of the servants were personal, the expedition only providing sufficient ammunition to keep them effective in case of need.

The instrumental outfit was as follows: universal magnetometer No. 20; Dover dip circle No. 223, with needles Nos. 1, 3, 5, and 6; theodolite-magnetometer No. 13; Kittel pocket chronometers Nos. 254, 259, and 260; Leroy watches Nos. 8282 and 8650; Howard watch No. 820; aneroid barometer No. 5; boiling-point apparatus No. 2; magnetic observing-tents Nos. 17 and 20.

The preparations had consumed some extremely valuable time. The entire month of October should have been available for travel, in order to avoid the hardship that would ensue by being overtaken by the hot season before arrival at Timbuktu. A working program was drawn up which should delay travel as little as possible and yield a maximum amount of data. Whatever magnetic observations the conditions of travel and energy of the two observers allowed were to be made every day; but on every third day of travel every effort was to be made to obtain a complete set of observations. This program was rigorously adhered to as far south as the military post of Motylinski.

An ordinary day of travel where the desert was mild was as follows: The party was aroused at 4 a. m., and 15 minutes were allotted to intercomparison of timepieces; during this time the cook prepared breakfast; $4^h\ 15^m$ to $4^h\ 30^m$ was assigned to breakfast; at $4^h\ 30^m$

the tents were removed and the loading was commenced; at 6^h, or $5^h\ 45^m$ with veteran caravaneers, the animals were loaded and the route was taken. As the travel was from one place of pasturage to another, wherever possible, the hours of march varied considerably, but a halt was generally made between 11 a. m. and 3 p. m., when the animals were immediately turned out to graze. The camels must have food; this necessity greatly limits travel in the Sahara. While the caravaneers were unloading, camp was pitched and if lunch was taken on board camel, as was our custom, the rest of the afternoon was free for observations.

The route between Biskra and Touggourt is frequently traveled, even by tourists. To avoid the discomfort of having to camp in the open, the government maintains caravansaries here called "bordjs." A "bordj" is a one-story rectangular mud building with stables and rooms built about a quadrangular open court, into which the animals may be brought. Where there is considerable travel, the "bordj" is kept by a keeper, who is tipped by the departing caravan leader. Between Touggourt and Biskra, such a "bordj," as also a well, is found at the end of every day's travel or "étape." Pasturage is also abundantly found every day, so that travel in this region is facile.

Leaving Biskra, the first magnetic observations were made at the end of 3 days of travel at the "bordj" of Steil; another station was established at Berzique, 3 days further on. Then after 2 more days Touggourt was reached on November 5. Two stations had been occupied and the caravan had not been delayed beyond the time ordinarily consumed in making that trip. On November 5, while Mr. Sawyer was making observations, a new caravan of 22 camels was hired, the escort was changed from mounted horsemen to "méharistes," men mounted on camels. On November 7, the route was resumed for Ouargla.

The desert from the north along our line of travel changed, not gradually but abruptly, from better to worse. Such a change occurred at Touggourt. The first day's march out of Touggourt was 8 hours to an oasis and water, where there was a small village; but the following day's march was 14 hours so as to have water at the "bordj" of Hassi Mahmar. On account of the long march of the preceding day, a halt of an entire day was made on the 9th, and complete magnetic observations were made. Two days with pasturage at the close of each day, but no water, followed, and then el Bour N'Goussa, a little oasis, was reached. A magnetic station was established here on the afternoon of arrival, and the march was resumed on the following day. The town and oasis of Ouargla was reached on that day, November 12. Here it seemed best, according to advice received from French officers, to buy the greater part of the camels for the more severe work to the south. A station was occupied at Ouargla by Mr. Sawyer, camels were bought, caravaneers hired, and as far as possible a final organization effected. The escort was increased to 6 men, in charge of Sub-Officer Constant, and on the morning of November 20 the expedition departed for In-Salah. Up to Ouargla hired animals had been used; from now on the main body of the animals was owned and controlled, and the caravaneers were paid by the expedition. Through this arrangement we controlled everything except the physical features that had to be encountered.

Another abrupt change for the worse in the character of the desert was developed south of Ouargla. Whereas pasturage had previously been met with throughout in sufficient quantity, now encampments were frequent where the pasturage was so scant as to be insufficient for the needs of the camels. The camels were living off of their humps. As this report may be of value to some members of the Institution in the near future, I will here take space to make some comment on this animal as bred in southern Algeria or in the severer portions of Sahara.

During the winter season, when the nights are cold, due to great radiation, and the days are hot, there is a great diurnal range of temperature, which may be as much as 35° C., from below 0° up. During this season camels bred in the region of In-Salah, when out in pasturage and not worked, will not return to a well of their own accord for water short of

10 days, according to the Arab owners of these animals. In an emergency one could count on the camel doing 15 days without water. But this statement needs to be applied with care by the prospective traveler, for let him be overtaken by the hot season and encounter temperatures of 50° C., and he will find that these animals will suffer after 36 hours. Incautious procedure will bring punishment under these conditions. As regards food requirements, the camel will not last long without any food; but he seems to have the power of storing a lot of reserve energy in the hump, which is the criterion of the condition of the animal. If the hump is large and fine, the animal is in good condition. When an animal with a good hump is taken, he may be used for a month or two over areas where pasturage is insufficient. Once the reserve of the hump has been expended, he gives way and is useless. He must either be abandoned or be put into a good pasturage for several months until he can recuperate and build up a hump again. Unless the route is missed, water is ordinarily not a serious problem in Saharan travel. Pasturage, however, is always a serious question.

South of Ouargla and as far as Fort Motylinski, observations, as many as feasible, were made practically every day, the work being alternated between Observer Sawyer and myself, one man taking charge of camp work, the other observing. At the expiration of every 3 days of travel, complete observations were made, generally without halting the progress of the party. The afternoon was devoted to observing as usual, but on the following morning 2 soldiers were retained as protection while the station was completed, and the main body of the caravan sent on at the usual time. After completion of the observations, the camp of the main party was rejoined by a forced march, which several times lasted well into the night.

Instead of following the direct route to In-Salah, the party was directed westward to El-Golea, in order that a last time-comparison with the observatory at Bouzareah might be obtained by telegraph. On November 22 Hassi Hadjar was reached, 2 stations having been established *en route*. Here occurred a curious incident. Three of the camels were reported blind by the drivers. A desert herb grows in this vicinity, the pollen or some other emanation from which gets into the eyes of the camel and blinds them, incurably, so the Arab affirmed. After repeated injections of mild carbolic acid solutions these animals recovered their sight. The soil here is apparently very alkaline, so much so that some of the wells have undrinkable water.

After Hassi Hadjar, a severe stretch of desert was encountered in which 6 days were spent without encountering water, but abundant pasturage was always found. In this interval the surface of the desert frequently presented itself as a surface of smooth, thinly-sand-strewn rock, so that several stations were established on sand dunes. Another curious physical feature was observed on the surface of this rock-plateau. At numerous intervals one encounters collections of rock broken to the size of railroad-ballast, rarely in heaps, but most frequently in circular groups, well scattered, as though some large rock had struck the surface of the plateau, exploded, and scattered these angular fragments.

El-Golea was reached on November 30. Here two more camels were bought and observations were secured. Departure was made on December 3. As before, the desert to the south of El-Golea was abruptly severer. On the 7th and 8th we passed over an especially barren tract of bone-strewn desert to the north of the deserted post, Fort Miribel, camping late on the afternoon of the 7th in absolute desert with no vegetation in sight, to obtain a few magnetic declinations while the cook tried a fireless kitchen.

Following the program of observations and travel already indicated, without mishap, after passing through several beautiful small oases in its neighborhood, In-Salah was reached on the afternoon of December 24. On the next day, in the afternoon, General Bailloud's trans-Saharan expedition arrived. General Bailloud had been in command of the 19th Army Corps of France and had already shown marked kindness and courtesy to

the members of the survey party while at Algiers. This energetic officer, just retired from active service on account of the age limit, was to do us one more favor. He had with him a recently-invented wireless receiving outfit. With this apparatus, time-signals from Eiffel Tower were successfully obtained, by aid of which our time work was put on a good basis.

From December 26 to 29 a sand blizzard was blowing, thus delaying work. On account of the lack of pasturage or purchasable animal food, this delay created difficulty. The camels could not be fed. After one had died from indigestion caused by eating dates, they were finally sent under escort of 2 soldiers to a pasturage 30 kilometers from In-Salah. While preparations for the more difficult half of the journey were under way, a 24-hour series of magnetic declination observations was carried out, as also the regular observations. While encamped here also, news was received of a successful attack upon the Berbers, by Captain Charley, commandant of the post at In-Salah, about a month and a half travel to the south of us, in the vicinity of Kidal. In this attack he was reported to have captured 300 camels and killed about 80 of the marauding Berbers. It was assumed that this event had cleared our route, for some time at least, of these marauders. The fact also that General Bailloud with an escort of 40 soldiers was making a flying trip over practically the same route that was to be followed later on at a slower pace gave additional promise of security and success for our party.

Our escort was now changed for Sahariennes of In-Salah and was increased to 8 men. Private Plainchamp was substituted for Sub-Officer Constant in the command of these men, who, as before, were camel men. A new set of caravaneers had to be engaged, as none of the men hired at Ouargla were willing to go beyond In-Salah. Two more camels were purchased. It seemed desirable to have several camels free from loads; besides, more weight was added by the increased amount of provisions which had to be carried for the caravaneers and servants. Provisions for these men could not be obtained until Motylinski was reached. One camel was loaded with dates, to be used in emergencies in tiding the weaker animals over starvation when pasturage would not be found. This was a precaution that saved us quite a few animals.

On January 2, 1913, all preparations having been made, In-Salah was left behind and the last and more difficult part of the trans-Saharan work commenced. The expedition was now constituted as follows: 2 magnetic observers, 1 interpreter, 2 servants (cook, caravan-chief), 6 camel-drivers, 7 native soldiers (commanded by 1 French private, Plainchamp), 5 servants and caravaneers of military convoy, or 24 men in all; 25 baggage-camels (bought by the expedition), 8 military riding-camels (mehari), 8 military convoy (luggage) camels, making in all 41 camels. The military-convoy camels carried the provisions and baggage of the soldiers. Eight animals were sufficient, as a fresh supply of provisions could be obtained from the military stores at Fort Motylinski.

Insufficient pasturage was found the very first day out. On the morning of the second day from In-Salah a small Tuareg caravan was met, with the animals loaded with hay made from a wiry desert grass. The leader handed us a note, forwarded by General Bailloud, warning us that we were going to encounter 3 days of travel without any pasturage or wood. We immediately purchased all the hay the Tuareg would part with for our animals, and that evening, to further save the animals, poured away half our water supply.

On January 4, after a long 8-hours' march, the caravan arrived at the wells of Hassi-el-Khenig, where water but not pasturage was found. The animals had had no pasturage the day before, magnetic observations were desirable, and another foodless day was awaiting the animals. Under the circumstances, a magnetic station was occupied by observing all night. In the morning the route was resumed. Before that day's march was over, one camel had to be relieved of his load and left behind exhausted. He was brought to camp late in the afternoon by a caravaneer left behind for the purpose, who drove him as fast as his condition permitted. That night he was fed dates and brought into shape to continue.

On the morrow every plant within sight was pulled out, or dug out with knives, and was fed the starving beasts as they plodded along. Foot-races ensued between the soldiers whenever an extra large clump of growth appeared. Each one was eager to obtain it for his own camel. On the 9th of January good pasturage and sweet water was reached in the gorge of Tibratne.

The desert here is mountainous; the gorge of Tibratne is a canyon with walls 200 or 300 feet high sunk into a rough, rocky, desert plateau, and of a width of about 50 yards. Two-hours' march from the mouth into this gorge is sweet water and good grazing for the camels. Four hours more of march in the bed of this gorge brings one out into a broad plain, flanked by a range of hills on either side. Here we halted for 2 days to allow the camels to recuperate from the starvation route they had just come through.

According to the men the biggest difficulty of the road had now been overcome. What remained was plain sailing. We had come across the "Tanezruft." Many times we had been told one thing and found it different. That we should have crossed the "terrible Tanezruft" so lightly seemed incredible, especially as in the travelers' books it was located much farther south. It seems, however, that any high, desert plateau of especial barrenness receives the name "Tanezruft" from the Arabs. The higher the altitude the greater the barrenness. It was later found that a high plateau of no matter what extent had almost invariably to be completely crossed and a descent to a lower level to be made before any vegetation or even passing pasturage for the camels could be found. For this reason the name "Tanezruft" has everywhere come to be associated with danger and hardship.

January 12 we passed out of the canyon of Tibratne and camped in the broad water draw at its mouth. On the 16th we were once more encamped in a narrow gorge and on the 17th, after a march of 15 hours, to avoid the necessity of camping without pasturage, we halted at the Hassi Meniet. On the 18th the animals and men were allowed to rest while magnetic observations were made.

Between Hassi Meniet and the wells at Tesnou is an interval of high desert plateau, such as the French call "reg," absolutely bare. Sufficient pasturage was cut at Meniet for one feeding of the camels and was loaded on the caravan. On the 19th we marched half way across this "reg," camping on it and feeding the animals with the pasturage carried.

On the 20th the wells of Tesnou were reached with many of the animals showing signs of distress. These wells merit description. There are three of them, about a third of the way up a cleft in the mountain of solid rock. They are arranged one above the other along the slope of the cleft. During our stay the upper two were dry, while the lower contained only a scant supply. Evidently the cleft gathers all the drainage of the big, rounded mass of unbroken rock which it splits, and provides a natural reservoir of a very limited supply. We halted here for a day to rest the camels and to make observations. Leaving Tesnou, insufficient pasturage was again encountered, and on January 24 the question of food for the animals became very grave. All the animals were very hungry and ate with avidity what dry, dead growth they found on the march.

One camel, called "Fatigué," was only kept going by a daily ration of dates. He had to be styled "Fatigué No. 1" later on. Off of our route, 6 hours to the right, a pasturage was reported by Abdullah, the Arab corporal, which he said was reputed to be always green. He was instructed to lead the caravan to the place as directly as possible. Arriving there at 11 a.m., we were favored beyond hope. There had been a rain within a month or two. The narrow "oued" between the bleak, gazelle-tracked hills was green with "mrokba." Even some succulent, low, green herbs, which the Arabs esteem of especial efficacy in restoring exhausted camels, were found. There was, however, no water, which was an objection to our staying there long. But there was a well 8 hours of travel away.

So we camped indefinitely to allow the animals to graze. Complete magnetic observations were made and on the 26th and 27th declination observations throughout 24 hours were secured. On the afternoon of the 25th, upon analysis of the situation, it was decided to remain in camp 2 days longer to pasture and rest the animals. Thereupon as soon as the moon rose Bershea, with 3 of the strongest camels, accompanied by 2 soldiers with several military camels, was sent to bring water for the party from the well 8 hours away. These men caused considerable uneasiness by not returning until hours after they were expected on the 26th, and the camels were called in from the pasturage in preparation for contingencies.

On January 28 the route was resumed to a well at Taourirt, and, on the 29th, we encamped at the first Tuareg village encountered, that of In-Amguel. The little oasis in which the village is located was visible, because of its brilliant green, from a great distance. There were no trees. The green was from irrigated oats patches. These were the first human habitations we met with south of In-Salah. The village lies in a little basin surrounded by very rough stony country, some dark-colored rock formation with no vegetation. The houses are small, rectangular, of interwithed water reeds. There are also 2 or 3 small mud houses. These people are so poor that they are reputed to cut fine some of the desert herbs, and, like their camels, eat them.

In-Amguel was left on January 31, some very rough, rocky, and hilly country being encountered. At the close of this day the caravaneers went on a strike in a body, declaring they were overworked and would die before Fort Motylinski was reached. They would go no further. They were told that if orders were not carried out in the morning as customary, the expedition would leave them behind. The strike lasted from 8 at night to 4 the next morning and so was perfectly harmless.

On February 1, a long march was made, and a severe sand squall, which lasted one-half hour, was experienced. No observations were made, as the weather was very windy and the observers as well as the caravaneers were tired. The second of February brought us to the practically abandoned Tuareg village of Tit. Here, in 1899, the Tuaregs had made a valiant but ineffectual assault on the French forces, the Foureau-Lamy Expedition, sent to subjugate them. At the base of a tremendous, domical rock, their bleaching bones give gruesome testimony at once to their bravery and their defeat. One of the caravaneers, Milhoud, expert hunter and ex-soldier, had been an actor for the French in that affair. Here we traded for wood and chickens with flour and sugar. This was one of the few regions where money was not the most useful medium of exchange.

On February 4, we marched from 6 a.m. to 6 p.m. During the half-hour halt near noon, bread was baked, tea was made, and a wounded camel was treated. On this march 2 camels gave way and had to be relieved of their loads. Camp was pitched that evening in the dark at Tamanrasset, where Mousa, chief of the Tuaregs, lives when he is home. On the 6th, Mousa's village was left. Passing to the east through the low basin containing Mousa's village and on the left of a high ridge of columnar rock (basalt?), over an extremely rough and rugged trail, up, down, right, left, interminably winding, the road was extremely hard on the animals, with but a small advance achieved. Another animal, Mr. Sawyer's riding-camel, gave way, and was added to the list of useless animals, which was growing uncomfortably large. Rest and pasturage were imperative. Meeting with good pasturage at the conclusion of the day's march, we halted indefinitely, until the condition of the animals should warrant moving. A natural basin at the foot of some rock hills contained water which the animals could use. But drinking water had to be brought from Mousa's village, after an attempt to find water by digging, the "tilmas" water proving too foul for a home-made filter-plant.

Leaving camp in charge of Observer Sawyer, I proceeded, on February 10, a day's march eastward to Fort Motylinski, French military post and depot of supplies, taking only

the interpreter and 2 soldiers of the escort. It seemed imprudent to take the caravan, as it was reported that there was no pasturage at Motylinski or in its vicinity. Upon arrival at Fort Motylinski I had reason to be glad the caravan was left behind at the pasturage where we were encamped, since the camels belonging to the post had to be sent 7 days' travel away to obtain good pasturage. The commandant, a sub-officer, greeted us and entertained us as royally as his means permitted. Consulting with him relative to our future plans, he suggested that we should go to Agades, and thence west to Timbuktu, adding 14 or more days to the itinerary, but assuring pasturage most of the way. He thought that to take the direct route, across "the Tanezruft" which lay 5 days' march to the southwest of where we were encamped, would cost the loss of 15 of the animals of the caravan, while not an animal would be able to go beyond Kidal, the first Sudanese post. In the Tanezruft we would encounter such heat that our tinned provisions would burst. As it was desirable, however, to have magnetic data from the Tanezruft, it seemed best to take the direct route. Through the kindness of the officer of the post, Tuaregs were found who could furnish 11 fresh camels in good condition. These Tuaregs with their camels were engaged to go with us as far as Kidal. Completing observations on the 11th, buying provisions for the Arab caravaneers left in camp, also a camel load of millet, to assist the starving animals in the passage of the Tanezruft, I rejoined our camp on the night of February 12, and found everything in readiness for instant departure. For two more days we remained in camp until the soldiers could secure camels to convey their provisions.

February 15, the route was resumed with 5 days of travel to bring us to the edge of the disreputable Tanezruft. Every precaution was taken to husband the strength of the animals for the trial they were to undergo. The caravaneers were forbidden to drive any animal unless he actually stopped moving. On February 20, we camped at Amselkat on the last good pasturage on our side of the Tanezruft. Here it is customary for caravans to halt to pasture their animals preparatory to hurrying across the Tanezruft. Never is a stop of less than 5 days made for this purpose. While we halted, the caravaneers, under the leadership of Isa ben Saad, cut the "drin," a tough, fibrous grass, with which the pasturage abounded. This was tied up into large bundles to load upon the camels. On the 26th, after a halt of 5 days, the Tanezruft was commenced. Eight camels carried only loads of cut "drin." On this morning one camel, Kaddour—he had been Observer Sawyer's riding-camel—was shot and abandoned, no amount of effort succeeding in getting him on his feet. Previous hard times had taken so much out of him that the 5-days' rest came too late. This was the only magnetic station that was left marked with a camel.

The first day's march into the Tanezruft was a moderate one, scant pasturage being found at the camping place. The following day a 9-hours' march was made and no pasturage found. That night the camp was aroused at 2 a.m. and the march resumed to $11^h\ 30^m$ a.m., when camp was pitched and a magnetic station was occupied. At this encampment a few scattered dry plants were found that were of no account as pasturage. Camp was aroused March 1 at $2^h\ 30^m$ a.m. and the march resumed until noon. At this encampment, observations were prevented on account of electrification of the instruments and tents by the wind and driving sand. There was no pasturage. This was the first station lost on account of physical conditions encountered. We were now in dangerous country, and the escort, desiring a march of 15 hours on this day, to be followed on the next day by one of 10 hours to the well, stayed in camp very unwillingly, being brought back after riding off. On the following day the expedition was aroused at 2 a.m. and the march was resumed up to $10^h\ 30^m$ a.m. During the night the wind, which caused some uneasiness, as it might render travel impossible, died down. The camels were fed as customary with carried pasturage.

Complete observations were made at the encampment of March 2. The party was aroused at 1 o'clock the following morning to resume the march. At 9 a.m. a piece of

exceptional fortune was met with; a shallow draw passed across was found green in patches with pasturage of an especially prized variety. A streak of rain had recently passed there. There was sufficient new growth to furnish several hours' pasturage. The animals were at once turned out to graze. At noon the march was resumed and by 4 o'clock the well Tin Ghaor was reached. Here was water after 6 days' travel, but no pasturage. The next morning Observer Sawyer, while attempting to make observations at this place, found such heavy static charges developed on the magnetometer that one-half inch sparks were drawn when any part of the instrument was touched, and the whole observing tent was so electrified that sparks were drawn when any part of it was touched.

At noon of March 3, after the animals had been watered, the march was resumed, it being desirable to make use of the short rest and refreshing effects of the water to get the caravan over the field of tremendous sand dunes across which the route lay. At 4 p.m. once more a small but unexpected bit of pasturage was encountered. Here at the foot of some cliffs we halted for the night without camping. On the 5th the march was continued from 5 in the morning to 1 in the afternoon, when an inferior pasturage of dry mrokba was reached, but the desert was found moderating.

The march on the next day brought us out of the Tanezruft. On this march a camel was abandoned. The ordinary routine of desert travel was now resumed, and on March 10 a small military depot of supplies was reached at Tin-Zaouaten.

On March 20 the well was missed, after 4 days' travel from the preceding well. Encampment was made without assurance of water. Soldiers and caravaneers, sent out in the afternoon and night, located water. Here another camel was shot and abandoned, and the march was directed to the wells at Hassi Yerlick on the following morning. The program of observations was now modified. Instead of observations every day, complete observations every second day of travel were substituted. This was a precaution against the unhealthful areas that were to be traversed south of Timbuktu.

On March 27 the Sudanese military post at Kidal was reached. Here it was found that a marauding party of Berbers, 300 rifles strong, was reported in the vicinity. They were a section, probably, of the band that had massacred, in June, 1912, Lieutenant Lorraine's strong detachment of Sudanese troops. All the available soldiers at Kidal, as also the escort that had been ordered there to relieve our Saharienne escort, were out in campaign against these Berbers, 14 black Senegalese troopers only being left to guard the collection of thatched mud houses and block house with a stone stockade, which constituted the military post of Kidal. If the military efforts to block up the routes to the north of the marauding party were successful, the Berbers might decide to assault Kidal. Under the circumstances, no soldiers were available for our escort.

Some time was at once spent in putting our party into a condition to take efficient part in any events affecting our safety. The captain commanding at Gao on the Niger was informed of our arrival by native messenger sent by the sergeant-in-charge at Kidal, and he immediately dispatched a detail of 6 black troopers and a black corporal for our escort out of Kidal. On April 8 the escort arrived. Allowing it to rest for a day, we resumed the route on the morning of April 10, directing our march not to Timbuktu but to Gao on the Niger. It seemed inadvisable under the circumstances to attempt a direct route to Timbuktu. During the enforced delay at Kidal the animals had recuperated wonderfully, with the exception of one, which died.

The Tuaregs and their camels from Fort Motylinski were sent back. Because of the military situation 13 fresh camels were hired to replace them. Every step was taken to insure the party against surprise by marauding bands, and, since a veteran organization was available, it was determined to pursue the route to the Niger with all speed possible, there to put irrevocably on record another successful crossing of Sahara. Marching at night, we slept where the loads were dropped from the animals. Halting during the mid-

day heat, a tent-fly over a thorny bush furnished shade while resting. Here our highest temperatures were encountered—temperatures between 49° and 50° C. being recorded under the observation tent at one station. During this stage of the expedition the marches were generally commenced at 5 in the afternoon and continued to 1 or 2 a.m., then resumed at daybreak and continued to 10 a.m.

On the night of April 19, after a short night-march of 6 hours, we entered Gao on the Niger, and camped in front of the official barracks. In the interval between April 20 and 23, caravaneers were dismissed, unnecessary equipment and camels were sold as far as possible, and steps were taken to proceed to Timbuktu by water. Through the kindness of the captain of Gao, two suitable pirogues (native canoes) were found and hired. The larger of these was practically a house boat, 30 feet long, its middle portion being covered with a roof of withes to which matting was tied. In this we lived and kept the instruments. The smaller one was loaded with provisions. When we were ready to embark, 7 camels remained undisposed of. At the river side two more were sold, and Isa ben Saad, caravan chief, directed to take the others overland to Timbuktu.

At 3 p.m. April 23, we were afloat and moving up the river, with a crew of 8 blacks on the living-pirogue, and 2 men in the provision canoe. The river was very low and progress was ordinarily made by poling, or towing from the shore. Deep stretches of water were paddled over. A feature of the river was the large amount of bird-life. Stepping ashore some minutes before dark a single discharge of the shotgun would not infrequently bring 3 or 4 ducks. At night the boats were tied up and we slept on the river bank. On several nights the hippopotami came up to 15 or 20 feet from the sleeping-places, making so much noise as to disturb our sleep. Not infrequently several herds of these animals would be passed in the river in a single day. Nearly every warm, sandy stretch of beach or island was full of sunning crocodiles. Altogether the most striking feature of the river trip to Timbuktu was not merely the bird-life, but the wonderful amount of all wild life. Magnetic stations were occupied at Bourem, Bamba, and Yoro.

On May 11 we arrived at Cabaret, the river port of Timbuktu, Timbuktu itself lying 17 kilometers north of Cabaret and not on the river. On the 12th, with asses for luggage-carriers, we passed from Cabaret into Timbuktu. It being reported that we were on foot and on the Cabaret road with an undignified jackass-caravan, the officers from Timbuktu sent horses from their own stables to meet us, so that the entry into Timbuktu might not be made ingloriously. It was the first of many kindnesses by the officers of Timbuktu. We were lodged by the civil administrator in a large mud house reserved for travelers and were assigned a guard whose duty it was to protect our property.

Mail, accounts, and monthly reports were now brought up to date. Then, in pursuance of instructions, the computations of the magnetic observations made in the desert were completed. Moreover, it was highly advisable that the routes to the coast should not be undertaken until the rainy season was over, on account of the dangers of the climate. In the interval between the last of June and July 11, intercomparison of the two instrumental outfits carried by the party were obtained preparatory to separation of the observers. Diurnal variation observations (declination) were also made, but not throughout the night hours; the almost nightly "tornades" created too great a danger to the instrument.

On July 20, all necessary work having been done, the party was separated, in accordance with the instructions of September 16, 1912. Mr. Sawyer took charge of the work to the coast by way of the upper Niger, railway, and Senegal River route. With him went the two Arab brothers, Joseph ben Saad and Isa ben Saad. I executed the work on the Niger River route to the Nigerian coast, accompanied by the European interpreter of the trans-Saharan party.

It has seemed best in this report to analyze separately the expenditure of time involved in the trans-Saharan expedition. The *time* included between the date of arrival at Algiers,

September 2, 1912, and arrival at Timbuktu, May 12, 1913, is here charged to the trans-Saharan work. While perhaps the river travel from Gao to Timbuktu, occupying 19 days, ought not to be so charged, the character of interior African travel is so uncertain that a statement of time or expense involved is of little assistance as a guide to undertaking similar work or even the same work some other time. The assignment of 19 days additional to the trans-Saharan trip then creates no difficulty. Using the above dates, we have an interval of almost 8½ months, or 252 days. Seventy-two stations were occupied, making an expenditure of 3½ days per station; 76 stations were occupied, if partial stations are counted. Preparations at Algiers consumed 2 months; the danger from Berbers used up 13 days; time lost in resting the animals consumed, not counting 1-day stops, about 15 days; while a sand storm accounted for 4 days. It is to be noted also that in this interval special declination observations were made at Algiers; a 24-hour series of declination observations was made twice and a 12-hour series once; and complete intercomparisons of instruments were carried out.

A fair assignment of *cost* to the Saharan work is $7,789. This includes the return transportation cost of the European interpreter, but not the cost of return to Biskra of the two natives, Josef ben Saad and Isa ben Saad. It is evident that the entire cost of transporting home all three of these men can not fairly be assigned to the less rigorous travel south of Timbuktu. This brings the average cost per station in the Sahara to about $108. About 1,800 miles of desert were traversed by camel caravan. As 72 stations were occupied, there was one station for every 25 miles of travel.

Magnetic conditions.—In the gorge of Tibratne, and again throughout the Tuareg country, and at several other places, the rock, sand, and gravel of the surface were found extremely magnetic. A bar-magnet wrapped with paper and drawn through the sand collected particles almost as readily as if the same experiment had been made with iron filings. The high static charges, encountered at several places, have already been mentioned in the itinerary account.

Assistance rendered.—It is a pleasure to record here the great interest taken in our work by the French officers, civil and military, that were met, as also to acknowledge gratefully the special pains taken by them to assure, as far as possible, the success of our work. Their effective and cordial aid at all times made possible the successful conclusion of the expedition. To General Bailloud, then commanding the 19th Army Corps of France, the expedition is under special obligations, not only for official assistance rendered but also for personal kindness extended. To him we are indebted for the military arrangements that furnished protection to the party; to him again we are under obligations for the use of a recently invented wireless receiving-apparatus at In-Salah, which allowed us from that remote station in the Sahara to obtain time signals from the Eiffel Tower, Paris. To Commandant Meynier of the Colonial Staff we are under special obligations for the advice and assistance furnished, out of his rich experience, in the preparation and equipment of the party at Algiers. Our comfort and safety from the physical features of the desert may largely be assigned to his care and solicitude.

Our gratitude is also due the Governor-General of Algeria, M. Lutaud, for great personal courtesy and interest shown in the work. We are under great obligation to all the officers and officials of Timbuktu, for courtesies received at various times, especially to Lieutenant Colonel Sadorge, commandant of Timbuktu, who, in addition to numerous kindnesses shown, furnished steel boats, with crews of military men, for our ascent and descent of the Niger.

We are under particular obligations also to Mr. Mason, American consul at Algiers, and to his clerk, Mr. Boisson.

The longitudes of the stations, as given in the Table of Results, depend upon chronometer and watch rates. The corrections of our timepieces were determined by compari-

sons with the observatory at Bouzareah, Algiers, and from the time-signals received from the Eiffel Tower, Paris, by wireless at In-Salah. From In-Salah to Gao, the longitude of which was accepted as furnished by the French authorities at that place, all longitudes are derived from a discussion of the times by the several watches carried, two of which behaved with remarkable consistency. Every care that could be thought of was given to the handling of the timepieces, and it is believed that about as good results as are possible by the method adopted were obtained. However, one refinement of care in the maintenance of uniform rates we did not practice, as it had not occurred to us. This was the plan of Captain Tilho, who, at every halt of his expedition, had natives march up and down all day with the timepieces, so that they might always be subjected to the same conditions. The longitude of Timbuktu by Captains Jordan and Harranger was obtained by telegraphic comparison with Dakar, which place is very accurately determined, having been checked against both Paris and Cape Town.

List of Stations, Trans-Saharan Expedition, 1912–1913.

1. Steil.
2. Berzique.
3. Touggourt.
4. Hassi Mahmar.
5. El Bour N'Goussa.
6. Ouargla.
7. Er-el-Aisha.
8. Hassi Metalla.
9. Hassi Hadjar.
10. Jarf-el-Bacra.
11. Arec Kanem.
12. El-Golea.
13. 2d encampment south of El-Golea.
14. Grun-el-Dehia.
15. Hassi-el-Meksa.
16. 5th encampment south of El-Golea.
17. Fort Miribel.
18. Dait Seddeur
19. Tabaloulet.
20. Dimissi.
21. Tilmas Ferkla.
22. 5th encampment south of Fort Miribel.
23. Mousa-ben-Yaich.
24. 7th encampment south of Fort Miribel.
25. Gouiret-ed-Diab.
26. Foggaret-ez-Zoua.
27. In-Salah.
28. 2d encampment south of In-Salah.
29. Hassi-el-Khenig.
30. 4th encampment south of In-Salah.
31. 5th encampment south of In-Salah.
32. Oued Tibrad.
33. 7th encampment south of In-Salah.
34. 8th encampment south of In-Salah.
35. 9th encampment south of In-Salah
36. 10th encampment south of In-Salah.
37. 11th encampment south of In-Salah.
38. 12th encampment south of In-Salah.
39. 13th encampment south of In-Salah.
40. Tesnou, 15th encampment south of In-Salah.
41. 16th encampment south of In-Salah.
42. 17th encampment south of In-Salah.
43. 18th encampment south of In-Salah.
44. 19th encampment south of In-Salah.
45. In-Amguel
46. 21st encampment south of In-Salah.
47. Tit.
48. 23d encampment south of In-Salah (Tamanrasset).
49. 24th encampment south of In-Salah.
50. Fort Motylinski.
51. Talanteidi.
52. 27th encampment south of In-Salah.
53. Tegueneouen, 28th encampment.
54. Hassi Amalaouly, 29th encampment.
55. Amselkat, 30th encampment.
56. 31st encampment south of In-Salah.
57. 32d encampment south of In-Salah.
58. 33d encampment south of In-Salah.
59. 35th encampment south of In-Salah.
60. 38th encampment south of In-Salah.
61. Tadeini, 40th encampment.
62. 42d encampment south of In-Salah.
63. 44th encampment south of In-Salah
64. 46th encampment south of In-Salah.
65. 48th encampment south of In-Salah.
66. Hassi Yerlick, 51st encampment.
67. 53d encampment south of In-Salah.
68. Kidal, 55th encampment.
69. Oued Eguerer, 2d encampment south of Kidal.
70. In-Tassik, 4th encampment south of Kidal.
71. 6th encampment south of Kidal.
72. Gao.
73. Bourem.
74. Bamba.
75. Yoro.
76. Timbuktu, *A* and *B*.

Explanatory notes.—Hassi, Arab term for well, in names of stations denotes a well. Oued means a drainage basin or valley; in these, pasturage, if there is any, is found. Inhabited points and posts at which observations were made were: Touggourt, El Bour N'Goussa, Ouargla, El-Golea, Foggaret-ez-Zoua, In-Salah, In-Amguel, Tit, Tamanrasset (23d encampment south of In-Salah), Fort Motylinski, Kidal, In-Tassik, Gao, Bourem, Bamba, and Timbuktu. The other points named are wells or pasturages.

In concluding this report, I wish to acknowledge the good service rendered by my chief assistant, Observer H. E. Sawyer, and desire also to mention the efficient service of the two guides, Josef ben Saad and Isa ben Saad, and of the hunters and caravaneers, Milhoud, Ali ben Kaddour, and Bershea.

D. W. BERKY, ON MAGNETIC WORK IN FRENCH WEST AFRICA, MILITARY TERRITORY OF NIGER, DAHOMEY, AND NIGERIA, JULY TO DECEMBER 1913.

On July 20, 1913, the trans-Saharan party was separated, and Observer H. E. Sawyer was put in charge of the party that was to go to Dakar. On the evening of the same day, accompanied by the interpreter and having an ass transport-caravan, I left Timbuktu in order to make Cabaret that night for an early departure in the morning on the barge furnished by Lieutenant-Colonel Sadorge. Two kilometers from Timbuktu a violent tornado overtook us, with pitch darkness, lightning, thunder, and pouring rain. After much trouble we camped in the middle of the road and spent the night in a very bedraggled condition. Early the next morning we arrived at Cabaret and found our crew was not yet ready to depart. However, at noon the crew poled us out into midstream and the descent of the Niger was commenced. Since the portion of the Niger between Gao and Timbuktu had already been covered by observations on the way to Timbuktu, no observations were made west of Gao.

Gao was reached in the evening of July 30. On the following morning the departure was delayed to 8 o'clock in order to permit time observations to be made. August 2 the military post at Ansongo was reached, where magnetic observations were made. The river journey was resumed at 3 p. m. the next day. On August 4 we encountered the first of the numerous rapids between Ansongo and Labbezanga; there were rapids and rocks most of the day, as also the next. By the close of August 5, a half-dozen holes had been punched into the bottom of the steel barge. On August 6, after passing through 3 rather strong rapids, we arrived at the principal rapids of the series, the rapids of Labbezanga. Here the river makes a drop of 6 or 7 feet in less than 100 yards. Having passed through the rapids safely, the crew was presented with a piece of mutton to celebrate the successful descent.

Immediately south of the rapids, on the island of Labbezanga, a magnetic station was established. South of the rapids the country for the first time begins to change its desert character, and trees of a fair size begin to appear. On August 12 the military post of Tillabery was reached and observations were made. The Niger in this region presents a curious condition. It is split into numerous branches, many of them small. Thirty kilometers is the reported width of the system of small channels into which the river is here divided. Not infrequently either bank of the channel we were following could be touched by one of the river poles of the crew.

On August 17 we arrived at Niamey and the magnetic station established here by Captain Tilho was reoccupied. During this stage of the descent, tornadoes accompanied by rain were of frequent occurrence. Say was reached on August 20 and observations were made after some delay on account of a tornado and rain. On August 23 we entered into an uninhabited belt thickly infested with the tsetse fly. During the whole day, instead of banks teeming with cattle and full of villages, only a few pigeons and some monkeys were seen. The fly here encountered is inferred from printed cuts of the tsetse fly to have been the *Glossina fusca*. Its bite had exterminated cattle and game, but was not fatal, so far as known, to human beings. Towards the evening of the 25th the tsetse nuisance began to abate, and that night we stopped at Bosia, the first native village on the south side of the belt. Here magnetic observations were made.

On August 29 we arrived at Gaya, the last French post on the Niger. Instead of continuing on the Niger to the coast, as originally intended, it was decided to leave the river and to follow the route of the "Mission Tilho" through Dahomey, reaching the coast at Cotonou. This change in plans was made because the river was considered impassable at Boussa in Nigeria on account of the rapids.

Negro carriers were engaged to carry the luggage, and hammock-bearers to carry the interpreter and myself. As a full camp-equipment and some provisions had to be carried,

25 porters were required. Only 2 men to carry the hammock are customary here, so that these have to be frequently relieved. Six men who relieve one another make a crew of hammock-men. We thus required 12 "hamacaires." This was our method of transport as far as Savé, the terminus of a railway from Cotonou. The route pursued is a very important one, as it is the only route by which the French may reach on their own territory the important post of Zinder. For this reason an attempt is being made to operate an automobile service between the railhead and the Niger. One of the autos of this service was tried on September 14 and carried us with extreme difficulty three carriers' marches, as far as Bambereke. Here it was given up on account of mud and carriers were resumed.

I had a mild attack of fever on September 13 while staying at Kandi. On September 17, after observing at Bambereke, I suffered another attack of malarial fever, and thereafter, until the coast was left, was continually harassed by mild attacks. On September 29 the railroad was reached at Savé. On October 2–3, observations were made at Bohicon, midway point on the railway, and on October 4 Cotonou, on the coast, was reached. Here mail was received and attended to, observations were made, observation records were put in final form, and the interpreter was sent home. On November 16 I arrived at Lagos, Nigeria, whence all records were transmitted to Washington and observations were made. On December 4 I left Lagos to return to Washington.

The instrumental outfit carried south of Timbuktu was as follows: magnetometer No. 13; Dover dip circle No. 223, needles 2, 3, 5, 6; Leroy watch No. 8650, and Kittel pocket chronometers Nos. 259 and 260.

The magnetic stations occupied south of Timbuktu were:

1. Ansongo.	5. Say.	9. Kandi (T).	13. Savé.
2. Rapids of Labbezanga.	6. Bosia.	10. Bambereke.	14 Bohicon.
3. Tillabery	7. Gaya (T).	11. Paraku (T).	15. Cotonou (T)
4. Niamey (T).	8. Goum Goum.	12. Kilibo.	16. Lagos.

Stations marked (T) are points previously occupied by the "Mission Tilho."

The field time of occupying these 16 stations required 136 days, or an average of $8\frac{1}{2}$ days per station. This large average is due to two causes: observer's illness in the field, and work done on correspondence and records at Cotonou. The field cost, exclusive of observer's salary, was $1,213.96, making an average field cost per station of nearly $76. About 1,200 miles were covered, 200 of which were by railway and steamboat travel, 300 by negro carriers, and about 700 by steel barge; this makes an average of about 75 miles per station.

As everywhere else, the French in the territory of Timbuktu, in the military territory of the Niger, and in Dahomey, whether in official or private capacity, extended every courtesy possible, every lone post entertaining us hospitably. In Lagos, Mr. A. Cleminson, acting head of the Cadastral Branch of the Nigerian Survey, extended special courtesy and showed great interest in the work of the Department.

The time and longitude work was based at Timbuktu on the determination by Captains Jordan and Harranger; on the Niger and through Dahomey on the determinations of Captain Tilho, and at Cotonou on the determination of the French Geographic Service.

F. BROWN, ON MAGNETIC WORK IN NORTHWESTERN AUSTRALIA, SEPTEMBER TO OCTOBER 1913.

In accordance with instructions from my chief of party, Mr. E. Kidson, dated September 15, 1913, I left Longreach, Queensland, on September 16, in an automobile, accompanied by Mr. McPherson. My instrumental outfit consisted of magnetometer No. 17, dip circle No. 172, pocket chronometer No. 258, Hamilton watch No. 107, and South Bend watch No. 400.

The stations occupied were as follows:

TABLE 8.

No.	Station	Date
		1913
1	Vergemont, Queensland	Sept. 17
2	Mayne Junction Hotel, Queensland	Sept. 19
3	Bedourie, Queensland	Sept. 22
4	Boulia, Queensland	Sept. 24
5	Urandangi, Queensland	Sept. 26–28
6	Camooweal, Queensland	Sept. 30–Oct. 1
7	Alexandria, Northern Territory	Oct. 2
8	Anthony Lagoon, Northern Territory	Oct. 4
9	Brunette Downs, Northern Territory	Oct. 6, 7
10	Cloncurry, Queensland	Oct. 13
11	Kynuna, Queensland	Oct. 15
12	Winton, Queensland	Oct. 17, 18

Vergemont cattle station was reached in the evening of September 16 after a good day's run of about 100 miles. I observed there the following day, and left the next morning for Mayne Junction Hotel, near the junction of the Diamantina River with its tributary, the Mayne. The track was very rough, especially over some low, red ranges, and the crossing over the bed of the Mayne River was exceptionally bad. No motors had previously attempted to get through, so that our car was the first to penetrate past Vergemont. After observing at Mayne Junction, I left for Boulia, which was reached the same night.

Next morning I set out for Bedourie, a small isolated township in the sandhill country. Some rocky, bare plains made traveling very slow, and the sand hills stopped us several times, the car having to be dug out. We managed to get around the sand hills, and by a piece of good luck we struck a very faint track which seemed to lead in the required direction. By following this we at last reached Bedourie late that night, one solitary light in the darkness marking the position of the township. As we were the first motorists through, the natives fled screaming from "the debil debil with the two bright eyes," as they termed the motor. I established a station next day, and, while observing, a small whirlwind suddenly struck the tent, the pegs were pulled out, as they were in loose sand, and the tent wrapped itself round both observer and instrument. No damage, however, was done, except the breaking of the suspension fiber. Bedourie is a township of 12 people and consists of a hotel, a store, and a police station, with one house and a few sheds.

On the return journey to Boulia, we were able to miss the worst parts of the road and so made a fairly quick journey. After observing at Boulia, I left for Urandangi, which was reached after almost a 2-days' run. Rain fell, delaying the observations for half a day, and then another 2-days' run took us to Camooweal, near the border of Queensland. After establishing a magnetic station here, I left for the Northern Territory. A few miles from Camooweal is the rabbit-proof fence which forms the boundary between Queensland and the Territory. A run of 120 miles took us to Alexandria cattle station and, after observing there, I left for Anthony Lagoon Police Station, the end of my outward journey. The lagoon is a fine, large, and deep waterhole, and it is a meeting-place for large flocks of parrots and cockatoos, and the home of ducks, geese, and other waterfowl. The work having been completed at Anthony Lagoon, I followed our tracks back to Camooweal, after observing at Brunette cattle station, between Anthony Lagoon and Alexandria. The country was not very interesting, large stony plains alternating with patches of the so-called "desert country," which was sandy and had gum timber and scrub. This contained kangaroos, emus, and wild turkeys, which were quite numerous in parts. No bush blacks, nor wild blacks, were seen, their camps being away from the trail and farther inland. Water was very scarce, and all cattle on the runs were round the bores, sub-artesian water being obtained. As the road between Camooweal and Cloncurry is very rough and hilly, and from all accounts impracticable for motors, it was necessary to return to Urandangi and thence to

strike the railway terminus at Duchess. Most of the track was very sandy and several sandy creeks gave us a great deal of trouble, the car having to be emptied of all gear; a track had to be made with branches of trees and with a few sacks and tent covers which were carried for such purposes. At one place it required 2 hours to travel 100 yards, and several trees were felled to supply leaves and branches for the track on which to run the car. As all the Cloncurry district is very rough, the car was sent by railway from Duchess to Gilliat, about 60 miles from Cloncurry.

After taking my observations at Cloncurry, I rejoined the automobile there and traveled to Kynuna, some of the track being very good and a speed of 30 miles an hour being attained for a considerable time. From Kynuna we continued to Winton, and observations were made at both places. At Kynuna, while putting away the dip needles, a swift whirlwind struck the tent, the pegs holding but the tent pole snapping, which in falling knocked the dip circle off the tripod to the ground. Luckily no damage was done to the instrument, probably due to the fact that the ground was soft, the base screws partly burying themselves. One of the hinges of the door was strained, but this was soon repaired. We returned to Longreach on October 18, 1913, the entire trip of 2,286 miles having taken a little over a month.

Fairly strong winds were experienced throughout, especially at Winton, and the weather was very hot, the heat being fortunately a dry kind. Water was very scarce everywhere and frequent 60-mile stages were passed where there was no water; for that reason few cattle were seen traveling on the stock-routes. Considering that such a great distance was covered, very little variety of country was met with, the majority of it being flat and devoid of timber, except the patches of desert country and the belts of bush around some of the creeks. No snakes were seen, but a number of iguanas and lizards were noticed, the iguanas being very numerous on the plains in the Northern Territory, where they are the favorite food of the aborigines. Provisions and also water in a water-bag were carried as a precaution in case of a break-down of the car in the wilds. Very few people were met on the road and on one 100-mile stage but 6 people were seen, 4 of these being cattlemen; 60-mile runs without meeting anyone were not uncommon. Cordial hospitality was shown at all the cattle stations called at, and the people met treated us very courteously.

F. BROWN, ON MAGNETIC WORK IN NORTHERN QUEENSLAND, AUSTRALIA, OCTOBER TO DECEMBER 1913.

In accordance with instructions from my chief of party, Mr. E. Kidson, dated October 21, 1913, I left Jericho for Rockhampton and thence by steamer for Cooktown and Thursday Island. My instrumental outfit was the same as for the previous trip in Northwestern Australia.

The stations occupied were as follows:

1. Thursday Island.	4. Mien.	6. Musgrave.
2. Mapoon Mission	5. Coen.	7. Cooktown.
3. Weipa Mission.		

After reoccupying on November 7 our magnetic station at Thursday Island, I left for Mapoon on November 13 on the *Beatrice*, an old pearling lugger of about 15 tons. Landing at Mapoon mission-station on the afternoon of November 15, I observed the following day and then tried to make arrangements to leave for Weipa, but was unsuccessful. During the ensuing delay here, I reoccupied the magnetic station and took hourly readings of declination for 24 hours. I finally succeeded in leaving Mapoon on the mission boat *I. G. Ward*, and traveled by her to Weipa mission-station, which was reached after a 2 days' sail. Completing the observations here, I left the following evening for Merluna cattle-station with 5 horses and a blackfellow. At Merluna I hired 4 horses and a black boy and proceeded to Coen. Mien telegraph station was one day's ride from Merluna, and

after observing there I left for Coen, about 70 miles away. The journey took two long days, I arriving at 10 o'clock one night.

As the boat between Port Stewart and Cooktown was not due till Christmas Day, I again had to hire horses to take me to Laura, the head of the railway from Cooktown. It being the end of the dry season, feed was very scarce, and the early storms had only just started the grass, so that the Coen horses were kept some distance away in the bush, where feed was more plentiful. While the horses were being brought in, I made my observations and then left, hiring 4 horses and gear, with a black boy, to take me to Laura, 170 miles distant. After 2 days' traveling, I reached Musgrave telegraph station and, after observing there, went on with the mailman, getting a change of horses at the mail-change on the Morehead River, where I sent my boy back with the old horses. Reaching Laura 2½ days afterwards, I went on to Cooktown and reoccupied our station there the following day. I left Cooktown on Christmas Eve for Melbourne and from there crossed to Hobart and rejoined my chief of party.

At the mission stations Mapoon (Reverend Hey) and Weipa (Reverend Brown) every possible assistance was rendered. The country traversed is throughout covered with thin gums and other eucalypts, and near Coen the tracks lead over the ranges, which are of no great height. Crocodiles are found in the rivers flowing into the gulf, and there are plenty of kangaroos and wallabies in the bush. The thunderstorms, which herald the approach of the wet season, started while I was at Mapoon, and were very frequent afterwards. After leaving Coen I found the creeks and rivers beginning to run and the last one, the Laura River, was running quite strongly, the water reaching to the saddle-flaps. The weather was very hot and the sun made the waterholes so warm that, at some places, the horses would not touch the water. I kept in good health and in the fever country occasionally took quinine. Though snakes are said to be plentiful in the bush, I saw only two, neither of which was poisonous; in some places the mosquitoes, flies, and sand flies were in swarms, and very troublesome, but my net protected me in the night.

H. M. W. Edmonds, on a Magnetic Exploratory Trip in Patricia, Canada, and to Hudson Bay, May to October 1913.

Acting in accordance with the preliminary instructions of April 3, 1913, and the final instructions of May 16, 1913, I left Washington on the latter date, accompanied by Daniel M. Wise as assistant observer, en route to Fort William, Ontario, to undertake a magnetic survey of a portion of the District of Patricia. The following instrumental outfit was assigned to the party: magnetometer No. 16; dip circle No. 222, with dip needles Nos. 1, 2, 5, and 6, and intensity needles Nos. 3 and 4; telescoping tripod No. 12; observing tent No. 22; pocket chronometer Kittel No. 226; watches Hamilton No. 70, Elgin No. 102, South Bend No. 568, and Mr. Wise's watch; pocket kodak No. 15; extra thermometers Nos. 8189 and 8187; pocket compasses Nos. 17 and 18; tape No. 22; tool kit No. 11; miscellaneous accessories.

The route followed was by rail from Washington, D. C., to Fort William, Graham, and Hudson, thence by water to Lac Seul (Hudson's Bay Company's post), thence by canoe by way of Root River and Lake St. Joseph to Osnaburgh and Fawcett's Post. From the last point we proceeded back on Lake St. Joseph to Cat River and Cat Lake. From there a side trip was made westward to Birch or Wigwasikak Lake and back. The trip was then continued by the Cedar River to Pakhoan Lake, then by various streams and lakes to Windigo and Trout (Fawn) Lakes. The Fawn River was then followed to Fort Severn, near the mouth of the Severn River. From there the shores of the Hudson and James Bays were followed to Fort Albany, at the mouth of the Albany River. We then proceeded

up the Albany River to Martin's Falls, Fort Hope, and Osnaburgh. Lac Seul Post was reoccupied and the party then returned to Fort William, where observations were made at the Canadian station of 1910. We then proceeded to Ottawa to compare instruments with those of the Canadian Magnetic Survey, arriving finally in Washington October 25. The stations occupied were as follows:

TABLE 9.

No.	Name	Date	Remarks
		1913.	
1	Lac Seul, H. B. Co. post	May 24–27	Very close to Fawcett's station.
2	Perch Ripple	May 30	Probably close to Fawcett's station.
3	Pigeon Portage	June 1	Very close to Fawcett's station
4	Lake St. Joseph	June 2, 3	Difficult to relocate Fawcett's station.
5	Fawcett's Post	June 5, 7	Exact location of Fawcett's station.
6	Osnaburgh House, H. B. Co. post	June 7, 8, Oct. 4	
7	Slate Falls, Cat River	June 11, 12	About 4 miles north of Fawcett's station
8	Ochichoo Chooena Rapids	June 14	Very close to Fawcett's station
9	Cat Lake, H. B. Co. post	June 15, 16, 20	Do.
10	Birch (Wigwasikak) Lake	June 18	
11	White Hill View	June 19	
12	Pakhoan Lake	June 25, 26	
13	Kakapeshe Lake	July 1, 2	
14	Pakayapon	July 6, 7	
15A	Island on Trout Lake	July 9	
15	Trout Lake, H. B Co. post	July 9	Close to spot usually occupied by surveyors.
16	Small Otter River	July 12	
17	Pettikau	July 14, 15	
18	Fawn-Severn	July 16, 17	
19	Fort Severn	July 19–26	
20	Signal Ridge	July 30	Hudson Bay shore.
21	Winisk, H. B. Co. post	Aug. 1	Near mouth of Winisk River.
22	Trout Harbor Island	Aug. 6	
23	Cape Henrietta Maria Island	Aug. 11, 12	Junction of Hudson and James bays
24	Opinnagau	Aug. 16	James Bay, mouth of Opinnagau River.
25	Naytahunga	Aug. 18, 19	James Bay.
26	Jekenakoshis	Aug. 20–25	Do.
27	Attawapiskat, H. B. Co. post	Aug. 27, 28	Near mouth of river.
28	Fort Albany, H. B. Co. post	Sept. 1, 2, 3	
29	Fishing Creek	Sept. 8	Albany River.
30	Chipie (Ghost) River, H. B. Co. post	Sept. 10, 11	Do.
31	The Forks	Sept. 13	Do.
32	Long Reach Bend	Sept. 16	Do
33	Martin's Falls, H. B Co. post	Sept. 19, 20	Do.
34	Fort Hope, H. B Co. post	Sept. 25, 26	Do
35	Greenwood Rapids	Sept 29, 30	Do.
36	Lac Seul, H. B. Co. post	Oct. 11, 12	Reoccupation of No. 1.
37	Fort William	Oct. 16, 17	Canadian station of 1910
38	Ottawa	Oct. 21–23	Magnetic hut of Dominion Observatory.

The total time occupied in the work was from May 16 to October 25, 1913, a total of 162 days. With 38 stations occupied, excluding the 20 days for travel from Washington to Lac Seul and back, the average would be 3.7 days for a station of the main part of the trip, or about 8 stations a month. The total distance traveled was approximately 5,312 miles, of which about 2,038 miles were by canoes from Lac Seul to Fort Severn and Fort Albany and up the Albany River to Lac Seul. The average distance between the 36 stations of the canoe trip was 56.6 miles. In the canoe work, 90 separate camps and days travel were made, giving a daily average of 22.5 miles. In about 1,500 miles of river work, 126 portages occurred, from a few yards up to 3.5 miles in length, with a total of about 30 miles, and an average of one-quarter mile to a portage.

Besides the regular magnetic observations, variation observations in declination, in accordance with instructions, were taken at Osnaburgh on a small island near Trout Lake Post (opposite side of the lake), at Fort Severn, and at Jekenakoshis. The weather was in

general too cloudy for observations of aurora. However, displays were seen on several nights, as follows:

July 19-20, Fort Severn. Faint streamers, scattered, not much motion.
July 24-25, Fort Severn. Streamers and sheet, generally distributed, not brilliant but making sky bright.
July 31-August 1, Winisk. Very bright aurora, generally distributed.
Aug. 5-6, West of Trout River. Bright aurora over whole sky, but not colored.
Aug. 26-27, Ekwan Point. Very bright aurora in north, especially 9 to 12 p. m.
Sept. 2, Fort Albany. Very fine, 3 large arches, then streamers, whole sky.

No magnetic storms at any time prevented observations, and only in a couple of instances did irregularities in observations make us suspect a magnetic disturbance.

Every care possible was taken of the instruments and watches; still they were subject to very varied treatment. Sometimes they were at rest in camp; at other times in the canoes, tossed about sometimes rather livelily by the waves; again they were subject to alternate canoe and portage travel. They were always under my own immediate care, within reach in case of accident, and they were always portaged by myself.

We are indebted to the officials of the Hudson's Bay Company for their uniform courtesy and desire to aid us. In particular I may mention the Commissioner of the Hudson's Bay Company at Winnipeg, Mr. N. M. W. J. McKenzie of Fort William, Mr. A. W. Patterson of Lac Seul, Mr. J. Margarson of Fort Severn, and Mr. Charles H. M. Gordon of Fort Hope. All of our stations at the Hudson's Bay Company's posts were on their grounds. I wish also to mention Mr. H. Dellaire, of Revillon Frères, at Attawapiskat, and Rev. J. T. Griffin, of St. Paul's Mission, Fort Albany. We are also indebted for many courtesies to Dr. Otto J. Klotz, assistant astronomer at the Dominion Observatory at Ottawa.

DETAILS OF THE TRIP.

Leaving Washington on the evening of May 16, Mr. Wise and I proceeded to Fort William, Ontario. Here arrangements were made with Mr. N. M. W. J. McKenzie, the manager of the Lake Superior district of the Hudson's Bay Company, for a letter of credit and introductory letters to the posts under his charge. Some personal outfitting was attended to at Fort William and the various points previously occupied by magnetic parties were visited. As the weather was not suitable for magnetic observations, we left on May 23 for Graham, where we were met by the manager of the Lac Seul district of the Hudson's Bay Company, Mr. A. W. Patterson, with whom we made arrangements to go on the next day to Lac Seul Post from Hudson by the Company's launch. The weather continued cloudy, with rain and quite a snowfall.

At Lac Seul we were able to make the first magnetic observations of the trip, hasty glimpses of the sun enabling us to obtain proper sights. We here obtained a complete outfit, comprising 2 canoes, 18.5 feet long, and a complete camping-outfit, with provisions for 6 persons sufficient to carry us to Fort Severn. The question arose as to the number and size of canoes—2 small ones or 1 large canoe. The small ones necessitated more men and required very skillful handling on the coasts of the Hudson and James bays. They were, however, more easily handled in narrow and shallow places, and, if anything serious had happened to one, the other would be in readiness for use. A single large canoe would have been heavy and in some places would not have stood the rough usage to be encountered in the shallow waters of the Albany. Moreover, if it had been smashed, we could not have obtained another at any of the posts after Osnaburgh. Hence 2 small canoes were finally decided upon to start with. It was extremely difficult to obtain Indians to accompany us for more than a few days at a time, and provision had to be made generally for transporting these Indians back to their homes. We at last obtained 2 Indians who agreed to make the round trip with us, and 2 more who went as far as Osnaburgh House.

Leaving the kindly hospitality of Lac Seul Post, where we were the guests of Mr. and Mrs. Patterson, we engaged at once in the rough work of the expedition. The first part

of the trip was on the lake to Root River, up this to Lake St. Joseph, then about 50 miles of lake travel to Osnaburgh. This proved rather strenuous work at first, paddling vigorously about 10 or more hours a day, with occasional portages. By hard work we managed to make this distance of about 153 miles in the very quick time of $3\frac{1}{2}$ days actual travel and 2 days for observations. About half of this distance was on the lakes and permitted the occasional use of the sail. Generally there are many islands on the lakes and many turns, and Indians make use of many cutoffs, so that it is very bewildering and much time might be lost by anyone trying to find his way without local guides. Root River, named after the number of roots and stumps in the stream, is narrow, except where it spreads out into small lakes. The current is rather slow, the fall in elevation taking place at the rapids or falls. There are 10 of these between Lac Seul and Lake St. Joseph, where it is usual to portage. The portage-trails on this stretch are usually short and over very good ground. All supplies for Osnaburgh House and Fort Hope and their outposts are taken every year by launch and York boats and freight canoes over this route from Lac Seul, and during this period there are always many Indians to be found along the line. The Hudson's Bay Company has built storehouses at convenient points for facilitating the transportation of the goods, but these are deserted at all other times.

So far as possible, the attempt was made to occupy the stations established in 1885 by Thomas Fawcett. At Lac Seul, from later information, we seemed to be a few feet to the NNE. of his point. At Perch Ripple we were perhaps within 100 yards, Fawcett's station being possibly across the stream. At Pigeon Portage we were probably within 50 feet, and at Fawcett's Post the exact spot is still marked by a post upheld by a pile of rock. During a greater part of the time it rained or stormed, but luckily it cleared off sufficiently for astronomical observations at exactly the places previously selected for observations. At Osnaburgh a series of 5-minute declination readings was taken.

Considerable difficulty was experienced at Osnaburgh in obtaining Indians to go further with us, only one of the Indians from Lac Seul remaining. This is the time of the year for the government Indian agent to make his rounds, and the Indians who belong to the treaty are summoned to their respective posts on certain dates to receive the government allowance of $4 a head for every man, woman, and child. There are also generally a feast and some sports with prizes, and most of the Indians had made their preparations to be present. We at last obtained 3 Indians who promised to make the whole trip with us, but one of these, a French half-breed, proved objectionable and was discharged later. The Indians in general were afraid of the long journey and the unknown perils of the route and because of the rumors of quarrelsome Indian tribes we would meet.

From Osnaburgh House we went back towards the west end of the lake and proceeded up Cat River to Cat Lake. The low state of the water compelled us at times to go off the regular line, and in that way we were not always able to occupy the stations of Fawcett. Ochichoo Chooena Falls and Cat Lake (Hudson's Bay Company post) were, however, very close to Fawcett's old stations. Slate Falls may have been anywhere from one-half to 4 miles distant. At Cat Lake I took one canoe very lightly loaded and 3 Indians, and made a trip about half-way to Whitestone Lake and then to the west to Birch or Wigwasikak Lake, Mr. Wise remaining at Cat Lake to make arrangements if possible for local guides for further work. A great part of the travel from Osnaburgh House to Cat Lake and to Birch Lake is on expansions of the streams into lakes. These are sometimes well dotted with islands and are subject to breezes which are considered dangerous by the Indians. Even more time could be lost on this part of the trip without local guides than on the previous part, on account of the less sharply defined streams. The portages become more difficult, owing to the swampy muskeg character of the ground. As far as Cat Lake the maps used, although "exploratory," gave the positions with considerable accuracy and detail. From Cat Lake to Pakhoan Lake and from Trout Lake to Severn, the details

were good but the positions faulty. From Pakhoan Lake to Trout Lake, the region covered by us was an absolute blank on the maps.

After my return from Birch Lake we continued northward to Pakhoan Lake. We met here a party of prospectors who were investigating the minerals of the region from Hudson to Lake Windigo and back to Cat Lake and to Winnipeg. They reported a total absence of anything worth looking at. By them we were able to send out letters, our previous opportunities having been at Cat Lake, Osnaburgh, and Lac Seul, from which points valuable mail may safely be sent. At the time of our trip, the route which we took by way of Windigo Lake and Trout (Fawn) Lake was unmapped and known only to the local Indians. It is used by the Indians of the region on account of the numerous lakes and streams where fish are abundant. We found it an exceedingly trying and difficult stretch, involving very many difficult portages and frequent changes of guides. One portage was 3.5 miles in length and difficult and took us a day and a half. Some of the lakes were stormy and occasionally held us up. On one lake, while trying to reach a suitable camp, we flew before the wind, all sails up, at a tremendous speed. On Trout Lake we took advantage of such a hold-up to take some declination readings, but were unable to obtain an azimuth.

Arrived at Trout Lake, we were again in a well-mapped region. The traveling was easier, as it was downstream. Instead of the oft times tiny, almost impassable waterways, we canoed down a gradually widening river, the Fawn, to its junction with the Severn, forming a swift and large stream. There were comparatively few portages, and the going was good. The Indians, as they got nearer Fort Severn, became more enthusiastic, expecting a grand time at that place. We found the post crowded with Indians, many of them from Trout Lake, who had come down with the factor of the Hudson's Bay Company to get the supplies of the Cat Lake post. The little steamer bringing these supplies from Nelson to Fort Severn had not yet arrived, and the food at Fort Severn was practically at an end. All the supplies at Cat Lake had been used up and that place was practically deserted. We were, however, hospitably received at Fort Severn and waited patiently, expecting daily to have to trust to our luck with the gun for further immediate food. Luckily the little vessel at last appeared, but only with provisions for the Cat Lake post. From these enough was requisitioned for our use by the Fort Severn factor to see us through to Attawapiskat, but the food was not very varied, consisting for the greater part of flour, water, and bacon. At Severn we made a series of declination readings, besides the usual magnetic observations. It is the first place after Lac Seul, and possibly Osnaburgh, where a fair check on chronometer rates would be possible. From here no other check occurs before Attawapiskat and Albany.

On account of the scarcity of food at the posts, it was now impossible to obtain guides. No one cared to leave his family unless certain provision could be made at the post for their care. We did obtain an Indian to help us to Winisk and another one on to Attawapiskat, both of whom proved rather incompetent. Our own Indians had by this time made up their minds to take whatever came along in the way of adventure, but it still took some time for them to get over their terror of the winds and waves of the open bay shore. The traveling was much different from the river work. Once out from land, no landing was made till we put in for camp. A supply of food and fresh water or tea was carried for the day. Sometimes we were caught out on the water by heavy storms and it was not possible always to get to shore. No more serious result happened than a scare for the Indians and a soaking of ourselves and of the provisions with salt water.

Along the whole line of coast of Hudson Bay and far into James Bay we found floating ice, sometimes forming an almost unbroken line of ice masses, at other times more scattered. This ice was sometimes several miles off shore, but on account of the shallow water we were often compelled to skirt along it. At other times it lay close in and we proceeded through

the midst of it. A number of seal would then be seen close to us. The prevailing winds seemed to us to blow across the ice and chilled us thoroughly. The coast is very low-lying, and the water shoals very gradually. There is also a great deal of loom and a general distortion effect of all objects near the horizon, so that at the distance we had to be from shore, except at high tide, we could either not see the shore at all or could distinguish no feature of the landscape. The tides sweeping along the shore might carry us back or forward without our noticing it. It was thus impossible for us to make even a guess at our progress. On the whole we were very lucky and managed to find fair camping places, and observation points at proper places. After leaving Winisk, no trees were visible except at a distance till near Opinnagau, well inside of James Bay. For firewood we depended entirely upon drift, and sometimes the only water obtainable was from floating ice. Wild fowl were plentiful and sometimes animals could be seen along the beach. The weather was generally cloudy, with many smart squalls and sometimes heavy winds. Fogs occasionally made traveling difficult. Our direction was held in such weather by keeping within a certain depth of water. This meant following all the little windings of the shore. These could be cut off to a certain extent in clearer weather, but it was not advisable to get too far out when the coast line was invisible, except for an occasional distant point that might be either a distant small rock lifted to view by refraction or a sea gull or duck.

At Winisk we found again a total absence of supplies. We occupied a station here and obtained an Indian to accompany us to Attawapiskat. At Cape Henrietta Maria we occupied the extreme outer edge of the island forming the turning-point between Hudson and James bays and, for lack of another name, called it "the cape to the island." The map positions of all the points of this coast are very many miles in error, with the exception of Fort Severn and possibly Winisk. From Cape Henrietta Maria, the latitude positions at least are good, and from this point the progress of the party could be followed very closely. It was, moreover, easier to get ashore. The weather was, however, worse, and the greatest delays of the trip occurred between the cape and Fort Albany. *A little below the point of the cape we noticed the heaviest deposit of black sand on the beach.*

Along the whole coast the rate of progress depends upon the time of the high tide. If it occurs early and late in the day, a good day's work can be done. If it is in the middle of the day, every thing has to be portaged out a long distance to water and some hours may be thus wasted every day. Moreover, the change of tide does not take place regularly, as the traveler is himself changing his position, and he may change just so as to keep the tide at its worst position of the day, or he may be held up by the wind so as to encounter the worst tidal conditions. The tides also race back and forth over and along the beach, so that in places it is absolutely impossible, with the expenditure of every ounce of effort of the men, to make a foot of headway against the tide. At too frequent intervals long lines of reef run far out into the bay, and these are often not disclosed until the canoes are very close to them; this necessitates a long detour straight out to sea or even back over the route, and, if the tide is bad, this may be impossible and the rest of the day be lost. Our best camping-places were on small islands, but sometimes we were caught in almost impossible places where there was no wood, fresh water, nor dry land.

Near Ekwan, sand and gravel bars extend for miles out into the bay, and probably the most dangerous part of the trip was at this point. We had been delayed for many days by the continued heavy weather and took advantage of the first passable day. The wind increased to such a force that with the cross-waves it kept us bailing the canoes continuously at the same time that it required great exertion to make any headway against the wind. It was imperative to make the point before low water, otherwise it meant many miles of portaging and the loss possibly of days. The Indians were badly frightened and almost refused to go further. We rounded the point at last in the roughest water for such canoes to live in and made a successful landing on a good beach.

Arrived at Attawapiskat, we were able to replenish our larder. We found an entirely different character of river and scenery from what we had been accustomed to see. After taking observations at the post, we left for Fort Albany. It was desirable if possible to make at least one station on Akimiski Island. Learning from the factor of the Hudson's Bay Company that a York boat would be leaving immediately for Albany and that there might be a possibility of making a landing on the island, we took advantage of the opportunity. The Indians are very careful in their selection of time in crossing. They generally go by night, when the weather is usually better than in the daytime. They start out if possible on a high tide and get there on a high tide. Otherwise there are miles of mud and extremely shallow water and adverse, impossible tides. Both tides and weather were unfavorable to us for canoe work, even at the nearest point of the island to Attawapiskat, a few miles away, and the further point of the island would have been too dangerous for anything but a York boat. The weather being unsuitable for observations, no attempt was made to reach the island and, after reaching Fort Albany, no further opportunity presented itself. Any further attempt would have invloved a possible delay of one to two weeks and would have cost from $200 to $400.

At Fort Albany it seemed best to make the trip up the river in one canoe, and we traded therefore for a larger canoe. We soon found that we lost much time by not having an Indian who knew the river and the one canoe proved too weak for the strain at the low stage of the river. It soon had so many holes in the bottom that we put ashore in a swamped condition and hastily landed all our outfit and made quick repairs to the canoe. Leaving a man in charge of the greater part of the outfit, we returned the same day to Fort Albany and traded back to the original canoes. We spent a couple of days in overhauling the canoes and engaged a local man to accompany us as far as Martin's Falls.

On September 5 we made our final start up the Albany River, tracking most of the way. We were able to make our observations about 50 miles apart in straight lines, sometimes, however, getting sun observations for only a fraction of a moment that had to be instantly utilized. The only places where we did not track was where we had to go far out into the stream to avoid shallows and bars. An attempt was made one day to sail up the river, but it proved to be time wasted. In tracking, one man sat at the stern of each canoe to keep it off the rocks and shallows, while 2 men were on the line. Every hour, or oftener, the canoeman was changed. A peculiar footgear called a shoepack is worn, but the tracking is such rough work that a pair of these shoepacks may be worn out in a day. Unless they are heavily packed inside, the wearer may have his feet out of commission in a few hours.

The current of the river is very swift and there are at low stages of the water innumerable shallows and bars that would make it impossible of navigation for even a very light-draft river steamer. The lower part of the river has many islands; above these the river is generally well defined. Most of the way the actual path of previous trackers can be followed, as it is well used by the Hudson's Bay Company, which tracks up all supplies for the river posts as far as Martin's Falls. On a part of this stretch, the walking is very easy and fairly level. There are, however, many miles where there is no room for a path and the trackers have to cling, as best they can, to the sides of the cliffs or force a way through the brush and small trees, or wade out into the stream. Where the snow hides the inequalities of the ground or conceals the edges of the banks, one goes stumbling along, often falling flat on the slopes, and the work then becomes very exhausting, but we made very good time as far as Martin's Falls. At this point the character of the river changes entirely and there is no more tracking.

At Martin's Falls we found only 2 Indians, servants of the Hudson's Bay Company, but managed to obtain one of these as a guide in place of the one from Fort Albany. Up to this point we had had only one light fall of snow, namely, on September 13, but on the 21st, after very heavy rains and storms, we had a heavy fall of snow, which lay on the ground to

the depth of a foot or two for many days. Portaging through this snow and through the brush was very hard and even dangerous work, and the provisions and general outfit became soaked and spoiled. The first part of this stretch is an almost continuous succession of rapids up which one has to pole the canoes, and around the worst of which one has to portage. For poling, long light poles shod with a steel and iron pointed shoe are used, the men standing up to the work. The man at the bow selects the way up through the midst of the rocks and keeps the canoe headed right. Much of the heavy work falls on the man at the stern. Poling is extremely cold work in wet and snowy weather. After the first two days, stretches of quieter water occur where it is a relief to take to the paddle. The rapids become shorter and more lakes intervene.

At Fort Hope it was no longer possible to hire extra Indians, but the way was known to one of our Indians and we proceeded onwards with three persons in one canoe and two in the other. We learned of the ravages of an epidemic of measles among the Indians between Osnaburgh, Lac Seul, and Hudson, many deaths having occurred, and our Indians were in a hurry to get home. They therefore went up rapids that were usually portaged around and sometimes carried immense loads on the portages. It is astonishing what rapids can be ascended by poling. At Osnaburgh a couple of time sights were obtained through haze, but it was found to be impossible to occupy Fawcett's post, the weather being so cloudy and the station being so situated that a permanent azimuth mark is impossible. After paying off our Osnaburgh Indians, we continued on our way with one Indian and one canoe to Lac Seul. It had been the intention to cross over from either Osnaburgh or from Fort Hope to Nipigon, but the lack of facilities in the way of guides, etc., prevented it. The companies themselves could not get Indians for their own work, and at places tried to get our men from us the moment they were free. At Osnaburgh we found some persons still sick and all others scattered in groups so as better to take care of the sick and yet obtain game and furs.

From Osnaburgh to Lac Seul the weather was very stormy and the travel dangerous. Sometimes we were held up in camp and at other times we flew before the wind or struggled as best we could against the winds and waves. We arrived at Lac Seul post on a very stormy day, which proved, however, to be the only one for several days on which we could have traveled on the lake at all. Here we took repeat observations, and paid off our only remaining Indian. We were again the guests of Mr. and Mrs. Patterson at the post. We found that there had been about 20 deaths among the Indians during the summer and that they had had two doctors at the post.

The continued winds and cloudy weather prevented any further observations at other points of the lake, so we proceeded to Hudson and then to Fort William, where we settled all our accounts with the Hudson's Bay Company. Observations were taken at the Canadian station of 1910, and then we proceeded to Ottawa to compare instruments with those of the Canadian Magnetic Survey. The observer of this service still being in the field, the comparison had to be made by observations by ourselves at the magnetic hut of the Dominion Observatory with our own instruments and with the Observatory earth inductor, to be followed later by observations by the Canadian observer with his own instruments; the variation observatory at Agincourt was to serve as the base of comparison. After the completion of this work we returned to Washington, arriving in the evening of October 25.

FACILITIES OF TRAVEL AND WORK.

Along the line of the railroad from Fort William to Graham and to Winnipeg there are at this time hotel accommodations only at Graham and at Minaki. Elsewhere one must either camp or trust to luck at the section-houses. On the construction lines to the east of Graham one should camp. At the central and district posts of the Hudson's Bay Company there is little knowledge of conditions and best means of travel outside the particular

district, unless the managers happen to have had personal experience elsewhere. Canoes and outfit obtained at a given post are such as are specially suited to the district. River canoes where rapids are frequent are not suited for coast work. River Indians of one place are not suitable for other places where the methods of fishing and game hunting are different, nor for coast work, until they have learned the ways of the country. This seldom causes inconvenience, except possibly in times of great scarcity of food, when it may be disastrous. The method of payment of the Indian varies much with the locality.

In most places visited, any Indian hired had to be transported at the end of his services back to his home under full pay and rationed, unless he were discharged for very bad conduct, or deserted. The means of transportation had also to be furnished. From Fort Severn onwards along the shores of the Hudson and James bays and up the Albany River at least as far as Martin's Falls, the man's family had to be rationed up to the day of his return. The Indians do not like to engage themselves for very long trips where the route is unknown to them, and especially where they pass into the territory of other tribes. There are certain times of the year when they are accustomed to be at the posts to meet the Indian agent or when they make their preparations to go away for the winter hunting; long trips are apt to interfere with their regular work, and may prevent them altogether from joining a hunting-party. There were two tribes of Indians met on the trip, the Ojibways and the Crees. The Ojibways inhabited the region of Lac Seul, Lake St. Joseph, Cat Lake, and connecting streams and the Albany. The Indians of the separate localities performed the duties of their particular locality with skill, but were often unskillful in the work of another even nearby locality. The Cranes, an offshoot from the Ojibways, inhabited the region near Windigo Lake and were rather looked down upon by the Ojibways of Lac Seul. Further along, on the branches of the Severn and at Fort Severn, the Crees are met. Very few of the Indians are full-blooded and in some places there is a very striking local type, most noticeable perhaps along the coast, due to the nationality of the white element. We never had any trouble with the Indians, finding them always friendly disposed. On the rivers most of them are expert, but some are very much better than others in the rapids. They all take pride in not letting anything happen to a white man in a canoe. Very few care to go on the waters of the bay except in very good weather. Very few of them are good shots.

Supplies can almost always be obtained at Lac Seul, Osnaburgh House, Attawapiskat, and Fort Albany, and generally at Fort Hope and possibly Martin's Falls. At Fort Severn and Trout (Fawn) Lake and Ghost River, on the Albany, supplies may usually be obtained after the year's supplies have reached the posts, which may not be till late summer or early autumn. At the inland posts one can not count on being able to get supplies at all. One can not depend upon a supply of fish from the streams, nor upon game. Along the coast there are usually plenty of wild fowl, and in places, as near Cape Henrietta Maria, there are large bands of caribou. Moose are occasionally heard and seen near the streams not too far north. Rabbits are numerous, and in places grouse, partridge, and ptarmigan. The Indians eat rat, owl, and other creatures not usually considered good by a white man. It is safer to take a full supply of food and not trust to the country. A little extra supply of tea and flour will often come in handy in trading with the Indians for fish and meat or to treat passing Indians and make them disposed to give information or render help. Game and fur laws of the country are strict.

Parties traversing this region usually obtain letters of credit from either the Hudson's Bay Company or from the French fur company of Revillon Frères. Both companies have posts at various points in the district, some of which are only winter posts. The French company having come into the country more recently, have as yet established posts at only the principal points of the coast and important points of the main rivers. As a rule one pays off the Indians by orders on the companies, but in the more southern portions of the region the Indians are becoming used to payments in money.

NOTES BY OBSERVER WISE.

Trees.—The most numerous and most widely distributed trees observed were the spruces. Both the black and white spruce were found in all timbered portions of the district traversed, the former seeming to be the more abundant. The largest trees occurred around the Lac Seul and Root River region, though fairly large spruce was also encountered along the lower Albany River. The tamarack was also widely scattered, but all of it which was large enough to be of commercial value had been killed by some pest, probably the larch saw-fly. Of the pines, the most numerous was the Banksian or Jack pine, noticed as far north as the Pettikau branch of the Fawn River and on the Albany as far north as the Kenogami. The Jack pine seemed most numerous around Lake St. Joseph and Cat River. The red pine observed were confined principally to Lac Seul, but a large point covered with red pine was seen on the northern shore of Lake St. Joseph. The balsam was very widely distributed, but it was neither abundant nor very large. Cedar was found widely scattered and as far north as the head waters of the Severn River, but never in large quantities nor of any considerable size. The wood is used by the natives for their canoe-frames. The white birch was found to be scattered pretty well over the region, except to the north of the Pettikau River. The birch was for the most part rather small, though around Lake St. Joseph and along parts of the Albany River it was of fair size. Two varieties of poplar occur throughout the whole region or nearly so. The white poplar (probably the aspen poplar) was the more numerous, but was very scarce along the northern reaches of the Severn River, and none was seen at the mouth of the Winisk. The black poplar (probably the balsam poplar) was very plentiful in this region, as well as throughout the district. The rowan or mountain ash was seen all along the Albany River, Lake St. Joseph, and Root River. A variety of low or ground maple was observed along the upper Albany River as well as at Lac Seul. The timber in many parts of the district has been either injured or destroyed by forest fires in recent years. This is particularly true of the region between Lake St. Joseph and Cat Lake, and also large areas between Pakhoan and Trout lakes. Along the coast between Trout River and the Opinnagau no trees whatever are visible. The woods in general are rather difficult to traverse except on beaten paths, on account of fallen trees and underbrush and tangled roots. Away from the river banks there is apt to be muskeg with innumerable ponds, streams, or lakes, making it very difficult to traverse. Of the smaller growth, the willow is the most useful to the Indian and is found very generally along the streams.

On James Bay shore, above Ekwan Point, the first *berries* were noticed. These were strawberries which were just ripening, and gooseberries which were quite green, but relished by the Indians in that state. On an island between Ekwan point and Attawapiskat a great many bushes were seen fairly loaded with ripe gooseberries. We found also a variety of small ground berry and a little berry looking and tasting much like a raspberry, but growing on a vine closely resembling the barren strawberry. Along the Albany River cranberries were quite plentiful and fairly large. The natives also ate with evident relish the mountain-ash berry and the fruit of the wild rose, which we found very palatable.

Minerals.—No indications of minerals were noticed during the trip except of iron around Lake St. Joseph and on Cat River, above the winter post of the Hudson's Bay Company, where black sand was seen that proved to be magnetic. Also just south of Cape Henrietta Maria the beach is well covered with black sand. On the banks of the Albany near Ghost River were places where an oil of some nature was oozing from the banks and forming a film over the small pools and puddles.

Fauna.—Of the fur-bearing animals, the Indians trap beaver, otter, marten, fisher, lynx, mink, muskrat, and fox throughout all this region in the district of Patricia. No bear were seen, but their tracks were occasionally noticed. Both black and gray wolves were seen. Caribou were seen only in the northern parts of the district; near Cape Henrietta Maria they were seen in herds of from 30 to 40, but in other parts they were seen only

separately and along the coast. Their tracks, however, were noticed on the Severn River as far south as the Pettikau.

Contrary to other reports of this region, red deer were seen at Cat Lake and 2 were seen between Cat Lake and Pakhoan Lake. Moose seemed very plentiful all along the Albany and Root rivers and on Lake St. Joseph, and on Cat River about as far north as Cat Lake if one might judge from the tracks. We were told by Mr. Gordon, the Hudson's Bay Company's factor at Fort Hope, that the moose seemed to be going farther north the last few years. Foxes were found specially numerous along the coast, where one might even run across a litter of young near the beach. Occasionally a ground hog was seen on the trip between Cat and Trout lakes, but nowhere else. Beaver-dams often obstructed the smaller streams and had to be destroyed to allow the passage of the canoes. Muskrat-houses were plentiful in the low grass and water growths of the streams. By far the most numerous of the animals were the rabbits, and they are probably the most useful to the Indians, as they are easily taken all the year, and provide food, clothing, and blankets. All the squirrels seen were red pine or ground; no gray squirrels were noticed. Chipmunks were plentiful.

Among the *birds*, robins, whisky-jacks, sparrows, ravens, loons, ducks, sandpipers, yellowlegs, and gulls were found in all parts of the district traversed. The ducks, yellowlegs, and gulls were most plentiful along the coast, where they were found in large numbers and many varieties. Ptarmigan were also plentiful along the coast. Two varieties of partridge were encountered along the rivers inland. A few geese and wavies were seen, but we had left the coast before they began to come down in any considerable numbers. Other birds noticed at various places were the bluejay, yellowhammer, woodcock, red-headed woodpecker, several varieties of hawks, several varieties of owls, sea swallows, kingfishers, nighthawks, etc.

Mosquitoes and gnats and a sort of large gad-fly were vicious, particularly between Cat Lake and Fort Severn. We understood that the cold snaps of spring had kept them down, and, except in the region mentioned, we did not suffer much from them. There were very many varieties of insects, beetles, ants, waterbugs, etc., and a whole season could have been profitably spent by an entomologist in the region. We found snakes only on the Albany. They are so scarce that our Indians had never seen any before.

Meteorological conditions.—Out of a total of 162 days from the time of leaving Washington till our return, there were only 30 clear days, namely: May 19, 25, 27; June 8, 9, 10, 19, 20; July 4, 10, 11, 14, 19, 23, 29; August 10, 11, 14, 18, 24, 27; September 5, 8, 9, 14, 17, 18, 30; October 15, 18. Rain occurred on the following days: May 17, 18, 21, 23, 24, 26, 28, 29, 31; June 1, 2, 3, 4, 5, 6, 7, 12, 13, 14, 15, 22, 23, 24, 25, 26, 30; July 2, 3, 5, 6, 7, 8, 13, 16, 17, 21, 22, 25, 26, 27, 28, 30; August 1, 2, 4, 5, 7, 8, 9, 15, 16, 17, 21, 23, 25, 26, 28, 29, 30; September 1, 4, 6, 7, 11, 12, 13, 15, 20, 21, 22, 23, 26; October 1, 2, 5, 6, 7, 10, 11, 12, 20, 21, 23, 24, 25, making a total of 85 days, or a little over half. There may have been some rain on other nights that was not noticed. Snow fell on the following days: May 23, 24 (heavy); June 6, 7; heavy hail June 15; September 13; heavy on September 20, 21, and 22; moderate on September 23, 26; October 5, 6, 11, 12, 20. There were heavy thunderstorms on May 31; June 1, 12, 13, 14, 15, 23; July 8, 17, 30; August 21; September 7, and October 10. The first freeze in still water was noticed on the night of August 24–25.

A great barrier of floating ice lay offshore on Hudson Bay from the time we struck the coast July 17 till we rounded Cape Henrietta Maria August 15, and it continued some distance into James Bay. It was much broken up and kept from 1 to 6 miles offshore, but sometimes was driven close inshore. The constant winds from these icefields made it very damp and cold, and the effect was very noticeable on the branches of the Severn, even between Trout and Windigo lakes.

C. K. EDMUNDS, ON MAGNETIC WORK IN CHINA, INDO-CHINA, AND SIAM, 1906 TO 1913.

The general magnetic survey of China, begun in 1906, has been conducted by me in accordance with the Director's initial instructions of November 11, 1905, and in cooperation with the Hongkong and Zikawei magnetic observatories, which have been used as base-stations throughout the work. Preliminary plans for the survey were discussed with Dr. W. S. Doberck, at the time director of the Hongkong Observatory, and with Reverend J. de Moidrey, S. J., in charge of the magnetic division of the Zikawei Observatory.

The survey could not be carried on continuously throughout each year, but only as my duties with the Christian College at Honglok, Canton, permitted, namely, during vacations and furloughs generously granted by the Trustees of the College. The salary of the observer, when on duty, and all field expenses have been provided by the Department of Terrestrial Magnetism. However, at times special facilities and free transportation of the party were furnished by officials and others; such courtesies and assistance will be found duly acknowledged in the appropriate places in this report.

The work accomplished up to the end of 1913 falls into two parts, corresponding to my two sojourns in China. The first period of active field work was from January 1906 to December 1908, and the second, from December 1910 to March 1912. During 1913 I was, for the greater part, absent from China in connection with the affairs of the Canton Christian College. No magnetic work could hence be undertaken in 1913.

No account will be found in this report of the magnetic exploration trip conducted across China, from Peking to the western borders, in 1909, by Observer D. C. Sowers. This expedition was one apart from my own special work and has already been reported upon in Vol. I, pp. 117–118.

The work in each period has naturally been divided into expeditions beginning and ending at Canton, my permanent headquarters throughout. In the first period these trips were:

I. January and February 1906, around the island of Hainan;
II. June to October 1906, along the central coast, from Hongkong to Shanghai, including the lower valley of the Yangtse;
III. January and February 1907, the southern coast, below Canton;
IV. August to December 1907, the northern coast, above Shanghai, and overland from Newchwang, in Manchuria, to Canton, via Peking, Taiyuanfu, Hankow, Changsha, and Kweilin;
V. September to December 1908, westward across Shantung and southward on the Grand Canal to the Yangtse.

In the second period the field expeditions were:

VI. July to September 1911, overland from Canton to the valley of the Yangtse;
VII. October 1911 to March 1912, along the south coast and in Yunnan Province, French Indo-China, and Siam.

Between the various expeditions as listed, considerable time was devoted at Canton to the computation of results and to the development of plans and arrangements for the next expedition, and in Hongkong and Zikawei (Lukiapang) to the comparison of instruments. During the sojourn in America, between my two periods in China, one month (September 1910) was spent in Washington comparing the new instruments with the Department standards.

Although Canton has been my headquarters throughout and a certain amount of travel, from Canton and back to Canton, was necessary in the case of each expedition, I have not, in determining the average of travel per station, included this with the more local travel in the actual region under observation, although practically every transit through Hongkong and Shanghai was utilized for making comparison observations with the Hongkong and Zikawei observatories.

The total number of distinct stations thus far occupied is 116, comprising 80 in China, 27 in French Indo-China, and 9 in Siam. The total travel, not counting the 2 round trips

from America to China, has been over 26,000 miles, of which about 11,000 miles have been involved in journeys from Canton to the local fields and return, and about 15,000 miles actually in the field, comprising 11,430 in China, 2,440 in French Indo-China, and 1,054 in Siam. The total cost of the field work thus far accomplished, exclusive of the observer's salary, but including some of the travel from and to America, has been about $5,335. Throughout all the expeditions the instruments were carried by coolies, except where the traveling was by boat or rail. Further details with reference to each expedition will be found below.

EXPEDITION I.—HAINAN, JANUARY AND FEBRUARY 1906.

Having secured, through the courtesy of Dr. Wm. S. Doberck, the loan of the Hongkong Observatory's magnetic equipment, I left Canton on January 13, 1906, to devote my winter vacation to securing magnetic observations in the island of Hainan, following the directions embodied in the instructions of November 11, 1905. The equipment thus obtained consisted of Kew magnetometer Elliott No. 55, Kew dip circle Dover No. 71, and a separate ordinary surveyor's theodolite for the astronomical determinations of position and azimuth. The Department of Terrestrial Magnetism supplied Hamilton watch No. 1 and chronometer Arnold and Dent No. 677, as also all the other accessories required for field work.

The Executive Council of the Canton Christian College extended my leave of absence one month beyond the vacation period, and I was thus able, although unavoidably delayed in starting, to complete the preliminary survey of Hainan as projected. After 5 days spent in Hongkong in preliminary observations and arrangements for the expedition, I left by French coasting-vessel on January 19 and reached Hoihow, the chief port of Hainan, on January 22, having stopped *en route* at the French concession of Kwan-chau-wan, where dip observations were secured. At Hoihow arrangements were made with Captain Roulet, of the small French freighter steamship *Hainam*, to cruise along the west coast from Hoihow to Leong Sui, making four stops *en route*. On January 30 I crossed the Hainan Straits in a native junk to Cape Kami, the southernmost point on the mainland of China, and here on February 2 the steamship *Hainam* picked me up. Inasmuch as my observations at Cape Kami were made in the vicinity of the lighthouse, the natives assumed that my work had some connection with the Lighthouse Service, the benefits of which they could readily appreciate, and this impression was of advantage throughout the rest of the expedition, in the course of which some districts were visited where white men were practically unknown. According to the arrangement made with Captain Roulet, almost every day was spent ashore observing, while the runs of the steamer were made by night. Only one serious storm was encountered, in which, although the vessel went aground, the mishap was not serious. I left the steamship *Hainam* at Leong Sui on February 9, and 2 days later started on foot to skirt the eastern side of the island northward in return to Hoihow. It was difficult to secure the necessary carriers because of Chinese New Year festivities, during which everyone is idle, but 4 good carriers were at length secured, and with a young interpreter, secured through the efforts of Dr. McCandliss of Hoihow, my party was complete. Kachek was reached on February 14 and Hoihow on the 17th, whence the return was made to Hongkong by a coasting vessel, and after 3 days spent in observations at the Hongkong Observatory and in computation of results, I reached Canton on February 23, where further observations were made, and on March 4 the instruments were returned in good order to the Hongkong Observatory.

The following stations were occupied:

1. Kwan-chau-wan, Kwangtung.
2. Hoihow, Hainan.
3. Cape Kami, Hainan.
4. Hiongpo, Hainan.
5. Yaichow, Hainan.
6. Yalinkan, Hainan.
7. Leong Sui, Hainan.
8. Kachek, Hainan.
9. Hongkong.
10. Honglok, Kwangtung.

The total time devoted to the field work of this expedition was 40 days, averaging 4 days per station. The time spent in actual travel was but 16 days and the total distance traversed was 1,780 miles, of which 1,295 miles were made on large steamers to and from Hainan, 320 miles by small steamer along the coast of Hainan, 125 miles on foot, and 40 miles by small sailboat through Hainan. Within the actual region of Hainan, therefore, the total travel was 485 miles, an average for the 7 stations of 69.3 miles per station. The total expense, exclusive of the observer's salary, was $170.81, or an average of $17.08 per station.

Observations were made on 13 days and no interruption was suffered on account of bad weather, except that on account of high winds and the small size of the observing tent, in comparison with the large size of the Elliott magnetometer, full observations for horizontal intensity could be secured at only 4 stations in Hainan. After my return to Canton, 5 days during April and as much time as could be spared from college duties through the first half of May were devoted to computation of results and to putting the records in final form for transmission to Washington.

Director Doberck and First Assistant F. G. Figg, of the Hongkong Observatory, rendered every assistance possible. Commissioner James Atcheson, of the Chinese Imperial Maritime Customs at Hoihow, gave me the privilege of residence at the Hoihow and Cape Kami lights, and Dr. McCandliss of Hoihow, and Messrs. Gilman and Lassell of Kacheck, missionaries of the American Presbyterian Board, rendered valuable assistance, as did also His British Majesty's Consul Hughes, at Hoihow, who secured from the taotai of the island a traveler's certificate and letter of introduction to local officials. Everywhere I was most kindly received by both the officials and the people and in no case encountered any serious interference with my work.

Hainan had been hitherto practically unknown magnetically. The results obtained show that the Earth's magnetic field at stations fairly well distributed around the whole coast is in general accord with that prevailing on the nearby mainland.

EXPEDITION II.—CHINA COAST FROM HONGKONG TO SHANGHAI AND LOWER YANGTSE VALLEY, JUNE TO SEPTEMBER 1906.

This expedition, along the central China coast between Hongkong and Shanghai and in the Delta of the Yangtse, was undertaken according to instructions dated November 11, 1905, and June 4, 1906. The instrumental equipment was generously loaned by the Zikawei Observatory through the good offices of the Reverend J. de Moidrey, S. J. The theodolite-magnetometer was of the Mascart type Chasselon No. 24 and the dip circle was Mascart-Chasselon No. 20. These instruments were received on May 7 and on May 19 to 21 were compared at the Hongkong Observatory with the instruments used in Expedition I. The timepieces carried were the same as in Expedition I, as were also the necessary field accessories. Besides the comparison observations made at Hongkong in May, 2 days were also spent in preliminary observations at Honglok (Canton) in the latter part of June, within which month 9 days were also spent in computing the results of the Hongkong comparisons and in making the necessary arrangements for the expedition.

I left Canton on June 26 and, after several days delay in Hongkong owing to the coasting-vessel repeatedly postponing its sailing, I left Hongkong on July 1 for Swatow. Throughout the entire expedition I was accompanied by Mr. Chiu Shing, a student of the Canton Christian College, who acted as interpreter and recorder. We journeyed northward by means of local coasting-vessels, making in all 6 stations between Hongkong and Shanghai, 3 of which were reached by separate side trips from the major ports of Swatow, Amoy, and Foochow. Shanghai was reached on July 28, where, after a conference with the acting coast inspector and the director of the Observatory at Zikawei, we embarked on a Yangtse steamer and proceeded to Chinkiang, and thence by launch to Yangchow and back. After reoccupying the station at Chinkiang, we returned to Shanghai by river steamer and

compared the Chasselon magnetometer and dip circle with the absolute instruments of the Zikawei Observatory, namely, Kew magnetometer Elliott No. 47 and Kew dip circle Cassella No. 14. After a side trip by rail to Soochow and return and further conference with the acting coast inspector, Captain T. J. Eldridge, we started on August 13 on a 2-weeks' cruise throughout the Chusan Archipelago on board the customs cruiser *Liu Shing*, which was making a round of the lighthouses in that region. The courtesy of traveling on the cruiser was extended by the coast inspector under instructions from Sir Robert Hart, inspector-general of the Chinese Imperial Maritime Customs, in response to my request, which was courteously forwarded to him by the Honorable W. W. Rockhill, then American Minister at Peking.

Captain Powell, of the *Liu Shing*, and his officers, rendered every possible assistance, and under instructions from Captain Eldridge, made special stops in addition to the regular visits to the lighthouses. In consequence of the facilities thus afforded for observing in the daytime and for rapid travel at night, 8 stations, 2 of which were visited twice, were occupied within the fortnight at places which would have been otherwise inaccessible. The *Liu Shing* brought me back to Shanghai on August 27, and on August 30 I left by coasting-steamer for Ningpo, returning again to Shanghai on September 3 after an unsuccessful attempt to reach the island of Chusan by launch from Ningpo, being thwarted in this attempt by sickness due to the intense heat and also by a prolonged storm. From Shanghai another side trip was made by means of a steam-launch and houseboat to Hangchow, from which place also, under the auspices of Mr. C. Pape, first assistant in the customs at Hangchow, a side trip was made to the mountain resort of Mokanshan. Returning to Shanghai on September 12, the next 2 days were devoted to further comparisons at the Zikawei Observatory. On September 15 we left Shanghai for Hongkong on the Japanese mail steamer *Sado Maru*, which, on the early morning of the 18th, encountered a very heavy typhoon and was consequently greatly delayed. I reached Canton on September 20.

On 2 days in October and 3 in November opportunity was taken to make further observations at Honglok, and in December 4 days were devoted to additional comparison of instruments at the Hongkong Observatory, a round trip being made from Canton for that purpose. During October, November, and December, about 16 days were also devoted to computation of results at such intervals as could be secured from my college duties.

The following stations were occupied:

1. Hongkong (reoccupied at close of expedition).
2. Canton (Honglok), Kwangtung (reoccupied at close of expedition).
3. Swatow, Kwangtung.
4. Chaochowfu, Kwangtung.
5. Amoy, Fukien.
6. Chuanchow, Fukien.
7. An Tau, Fukien.
8. Foochow, Fukien.
9. Yangchow, Kiangsu.
10. Chinkiang, Kiangsu.
11. Chinkiang B, Kiangsu.
12. Zikawei, Kiangsu (reoccupied after 24).
13. Soochow, Kiangsu.
14. Gutzlaff, Chusan Archipelago, Chekiang (reoccupied between 18 and 19).
15. Bonham, Chusan Archipelago, Chekiang.
16. Putu, Chusan Archipelago, Chekiang (reoccupied between 18 and 19).
17. Peiyushan, Heishan Islands, Chekiang.
18. Kunsuwan, Kue Shan, Chusan Archipelago, Chekiang
19. North Saddle, Chusan Archipelago, Chekiang.
20. Shaweishan, Chusan Archipelago, Kiangsu.
21. Liuchiao, Tsungming Island, Kiangsu.
22. Ningpo, Chekiang.
23. Hangchow, Chekiang.
24. Mokanshan, Chekiang.

The total time devoted to the field work of this expedition, including the observations at Honglok and the comparisons at Hongkong both at the beginning and the end of the trip, but not counting the time spent at Canton in the reduction of the comparison observations and making the final computations at the close of the expedition, was 100 days, or an average of about 4 days per station. Observations were made on 50 days and bad weather prevented observations on only 9 days in the entire period. The total time actually spent in travel was 33 days and the total distance traversed was 4,501 miles, comprising 3,355 by ocean and river steamers, 555 on the customs cruiser *Liu Shing*, 206 by launch, 146 by

sailboat, 100 by rail, 30 by carriage, and 109 on foot. Not counting the return ocean voyage from Shanghai to Canton, the average travel per station was 134 miles. The total cost of the field work of this expedition, including the comparisons made at the beginning and end, was, exclusive of observer's salary, $341, or an average of $14 per station. This low figure is largely due to facilities provided by the Chinese Customs Service, as noted above.

Previous observations for dip had been made at Swatow and Amoy by Dr. Doberck in 1883,[1] using the instruments which I had employed in Expedition I. His results may, therefore, be directly compared with mine by means of the comparison of the Chasselon and Elliott instruments made at Hongkong in May, as already referred to. At Chinkiang observations had previously been made by the Reverend Chevalier, and I reoccupied his station as closely as possible. It would appear, however, to be locally disturbed, as the dip at Station A, while agreeing with the values obtained by him, is not in accord with those observed at Soochow to the south and Yangchow to the north, but on occupying Station B, about a mile and a half to the south of Chevalier's station, I obtained values of the dip concordant with those at Yangchow and Soochow. With this exception, I believe that the results secured along the coast and in the Yangtse Delta will show an unaccidented field.

Besides the very valuable assistance rendered by the Customs Service, as already referred to, and the most effective aid received from the Reverend de Moidrey, my expedition was facilitated throughout by the foreign missionaries met with, and in particular by the Honorable E. Carleton Baker, then vice-consul and acting-consul at Foochow, and by Mr. J. F. Newman, then the agent of the Standard Oil Company at Chinkiang.

EXPEDITION III.—SOUTHWESTERN KWANGTUNG, JANUARY AND FEBRUARY 1907.

This brief expedition along the southern coast of Kwangtung was undertaken in accordance with instructions dated June 4 and December 3, 1906. The instrumental equipment and field outfit were the same as in Expedition II. In January, 6 days were devoted to observations at Honglok, comparisons at the Hongkong Observatory, and to the making of the necessary arrangements for the proposed expedition. This work involved a round trip between Canton and Hongkong.

After further preliminary observations at Honglok on February 1, I left Canton on the 7th for the south coast. I was accompanied throughout by the Reverend Charles E. Patton, of the American Presbyterian Mission of Yang Kiang, who courteously afforded me the privilege of joining him on one of his missionary journeys. In view of the facilities thus put at my disposal, it was not necessary for me to employ an interpreter or recorder or to provide my own cook; I had merely to share in the expenses of Mr. Patton's expedition in proportion to the coolies and boats required for the extra duty my expedition involved. The trip from Canton to Yang Kiang was made in a native junk towed by a steam launch and occupied the best part of 3 days. From Yang Kiang we went overland on foot almost due west to Kochow and thence by native houseboat to Fachow, and thence southeasterly on foot to Shuitung, where a small steamer was taken which carried us back to Canton on March 3.

Observations that would have been made at Muiluk and Shuitung were prevented by rain and the fact that no other steamer would be available within a reasonable time for return to Canton. Further observations after return to Canton were also rendered impossible by continual rain during March and April, but some 3 days were spent in a reduction of the observations secured at the following stations occupied in the course of the expedition:

1. Canton (Honglok) Kwangtung (reoccupied between 2 and 3).
2. Hongkong.
3. Yang Kiang, Kwangtung.
4. Kochow, Kwangtung.
5. Hua (Fachow), Kwangtung.

The total time devoted to the work of this expedition was 33 days. Observations were made on 10 days and were prevented on 3 days while in the field by bad weather. The

[1] *Terr. Mag.*, vol. 1, 1896, p. 40

average field time per station, when allowance is made for the travel to and from Canton, was a little more than 5 days. The total travel involved on this expedition was 986 miles, of which 360 were on a large steamer, 446 on a launch, 30 in a houseboat, and 150 on foot. Not counting the two long sea trips, the total field travel was only 360 miles, or an average of 72 miles per station. The total cost of the work reported on as of this expedition, not counting the observer's salary, was $73, or an average of less than $15 per station.

EXPEDITION IV.—NORTHERN COAST ABOVE SHANGHAI AND OVERLAND FROM NEWCHWANG TO CANTON, AUGUST TO DECEMBER 1907.

This expedition along the northern coast and overland from Newchwang, in Manchuria, to Canton, in Kwangtung, via Peking, Taiyuanfu, Hankow, Changsha, and Kweilin, was undertaken in accordance with instructions dated April 2, 1907. I was accompanied throughout by Mr. C. K. Yue, a student of the Canton Christian College, who acted as recorder and interpreter. The instrumental equipment comprised magnetometer and theodolite C. I. W. No. 2 and dip circle Dover No. 171, which were supplied by the Department, as well as the chronometers and other accessories. During May and June about 4 days were spent on correspondence and plans relative to the proposed expedition, and in July a special trip was made to Hongkong to obtain the magnetometer shipped from Washington.

After 2 days at Honglok (Canton) spent in comparing magnetometer C. I. W. No. 2 with Chasselon No. 24, which had been used in Expeditions II and III, I left Canton for Hongkong on August 3, and there devoted 2 weeks to making comparisons between magnetometers C. I. W. No. 2 and Elliott No. 55, which had been used in Expedition I, and to further comparisons between magnetometers C. I. W. No. 2 and Chasselon No. 24. On August 19 I left Hongkong for Shanghai, arriving there on the 22d. On August 23 I obtained at the Zikawei Observatory dip circle Dover No. 171 and various field accessories, including pocket chronometer Kittel No. 231, which had been left there for me by Captain Peters, in command of the Department's survey vessel, the *Galilee*. After 6 days spent in the comparison of dip circle Dover No. 171 with Chasselon No. 20, which had been used in Expeditions II and III, and in further comparisons of magnetometer C. I. W. No. 2 with Elliott No. 49, the absolute instrument of the Zikawei Observatory, I left Shanghai by river steamer on August 30 and proceeded to Kiukiang, on the Yangtse. My work at the Zikawei Observatory was considerably interrupted by an attack of incipient cholera, from the effects of which I did not fully recover until the latter part of October. However, after the first week I was sufficiently well to be able to travel and to carry out my schedule as planned.

The trip from Shanghai to Kiukiang and return was made necessary by the sudden resignation of Dr. O. F. Wisner from the presidency of the Canton Christian College, so that I had to proceed to Kuling, the mountain resort near Kiukiang, in order to arrange that the executive duties at the college would be properly discharged by someone else during my absence. Because of Mr. O. D. Wannamaker's courtesy I was enabled to proceed with my expedition in spite of Dr. Wisner's resignation. Advantage was taken of this round trip on the Yangtse to secure magnetic observations at Wuhu and Nanking. I reached Shanghai again on September 10 and conferred with the coast inspector, Captain William Tyler, who, acting on the instructions of Sir Robert Hart, referred to in the report of Expedition II, extended to me the privilege of traveling on the customs-cruiser steamship *Pingching* on its round of the northern lights between Shanghai and Newchwang.

After further comparisons at Zikawei on September 11 to 14, I left Shanghai on the *Pingching* at noon on September 14, and arrived at Newchwang on the evening of the 23d, having occupied 5 stations *en route*, 4 of which would have been entirely inaccessible except for the facilities thus afforded by the Chinese Customs Service. Captain Wiley and his officers of the *Pingching* afforded every possible assistance.

From Newchwang I went by rail to Peking, reaching there on the night of October 3, having occupied 3 stations *en route* and having been somewhat delayed in Tientsin by

attempting to locate Fritsche's former station. In Peking I conferred with Sir Robert Hart, inspector-general of the Chinese Imperial Maritime Customs, and with those in charge at the British and American legations, through whom I made arrangements for traveler's certificate for my journey southward through the provinces. Thanks to the assistance of the bishop in charge of the mission of the Greek Church, I was able to reoccupy Fritsche's former station in Peking almost precisely. I left Peking by rail on the night of September 9, and from Chentow, in Chihli, made a round trip to Taiyuanfu, in Shansi, having been provided with free transportation by the engineer-in-chief of the Shansi Railway, then under construction, the latter half of the journey being made on work trains and the last few miles on horseback through the courtesy of Principal Soothill, of Shansi University. Returning to Chentow, I again proceeded southward by rail to Hankow, occupying 3 stations *en route*. From Hankow a round trip was made by river steamer to Kiukiang, and on November 1, I left Hankow by steamer for Changsha, in Hunan, intending to observe *en route* at Yochow, which, however, was prevented by storm. I left Changsha in a houseboat on November 6 at noon and proceeded southward up the Siang River to Hengchow, which was not reached until the evening of the 15th on account of adverse winds. From Hengchow I proceeded overland on foot to Kweilin, in Kwangsi, which was reached on the afternoon of December 2 after considerable delays on account of heavy rains. From Kweilin we descended the Fu River in a houseboat, arriving at Wuchow on December 12, after 7 days of travel. From Wuchow the return was made to Canton by way of Hongkong on the regular river steamers.

The following stations were occupied:

1. Honglok, Kwangtung
2. Hongkong.
3. Zikawei, Kiangsu (reoccupied between 5 and 6).
4. Wuhu, Anhwei.
5. Nanking, Kiangsu.
6. Southeast Promontory, Shantung
7. Northeast Promontory, Shantung.
8. Kungtungtao, Shantung.
9. Chefoo, Shantung.
10. Howki Island, Gulf of Pechihli.
11. Newchwang, Shengking.
12. Chinchowfu, Shengking.
13. Shanhaikwan, Chihli.
14. Tientsin, Chihli.
15. Peking, Chihli.
16. Taiyuanfu, Shansi.
17. Chentow, Chihli.
18. Changte Ho, Honan.
19. Chengchow, Honan.
20. Chumatien, Honan.
21. Hankow, Hupeh (reoccupied between 22 and 23).
22. Kiukiang, Kiangsi.
23. Changsha, Hunan.
24. Hengchow, Hunan.
25. Yungchow, Hunan.
26. Kweilin, Kwangsi.
27. Wuchow, Kwangsi.

Stations Nos. 9, 11, 13, 14, and 15 were, as far as circumstances would permit, practically reoccupations of those of Fritsche, 1871 to 1883, although, with the exception of the station at Peking, the precise location of his station could not be reoccupied. During January, February, and March 1908, such time as could be spared from my college duties, amounting in all to about 10 days, was devoted to computation and preparation of records and photographs, but no observations were made.

The total time devoted to the work described under this expedition was 4 months and 24 days. The actual time spent in the field, not counting the journey from Canton to Shanghai but including the time devoted to observations at Honglok and Hongkong before starting out, was 137 days, or an average of 5 days per station. Observations were made on 54 days and were prevented by bad weather on 28 days. The total travel was 5,783 miles. of which 1,000 were by ocean steamer, 2,115 by river steamers (including 900 on the Yangtse for the special trip mentioned above), 808 on the customs cruiser *Pingching*, 1,340 by rail (215 of which were by courtesy of the Shansi Railway), 315 by sailboat, 10 on horse, and 195 on foot. The actual travel in the region of observation, not counting travel to and from the field, was 3,883 miles, which required 48 days. The average travel per station was 144 miles. The total expense, including the travel to and from the field, but not including the observer's salary, was $818, or $30 per station.

In addition to the facilities afforded by the Customs Service, as already mentioned, assistance worthy of special note was also accorded by the United States consul at Newchwang and the United States consul-general at Hankow. Assistance and courtesies were also extended by various missionaries *en route*, and the cordial cooperation of the Zikawei Observatory must again be acknowledged.

EXPEDITION V.—ACROSS SHANTUNG AND SOUTHWARD ON THE GRAND CANAL TO THE YANGTSE, SEPTEMBER TO DECEMBER 1908.

No field work could be undertaken during the summer of 1908, owing to serious failure of my eyes in March and April, from which I did not fully recover until September. However, in the fall this expedition westward across Shantung and then southward by the Grand Canal to the valley of the Yangtse was undertaken in accordance with instructions dated May 21, 1908. As in the previous expedition, I was accompanied throughout by Mr. C. K. Yue. The equipment was the same as that for Expedition IV, except that pocket chronometer Kittel No. 231 was lacking because of its loss by theft.

After about 7 days in the latter part of September devoted at Canton to preparations for the proposed expedition and after making preliminary observations at the base station at Honglok (Canton), in which I was seriously interfered with by prolonged rains, I left Canton on October 2 and boarded the steamship *Monte Eagle* at Hongkong for Shanghai, which was reached on October 7. The same day I took a steamer for Tsingtau, the port of the German concession of Kiaochow, in Shantung, where I arrived on October 9. Here I was well received by the director of the German naval observatory. Leaving Tsingtau on November 11, I proceeded westward by train to Tsinan, which was reached on the night of the 15th, after occupying Weihsien *en route*. From Tsinan I journeyed southwestward by cart to Tsining, on the Grand Canal, which was reached on the night of October 30, I having been greatly delayed by bad roads and very troublesome carters. From Tsining I journeyed southward on the Grand Canal by houseboat to Tsingkiangpu, which was reached on November 14, 2 stations having been occupied *en route*. From Tsingkiangpu a steam launch was taken to Chinkiang, on the Yangtse, which I ascended by river steamer to Kiukiang and from thence went by launch to Nanchang, the capital of Kiangsi Province. It was then my intention to proceed southward, ascending the Kan River to its headwaters, then to cross the Meiling Pass on foot to the headwaters of the North River, in Kwangtung, and descending this to reach Canton; but at Nanchang, after an exchange of telegrams with Canton, I found that the college affairs demanded my immediate return and, consequently, after observing at Nanchang, I descended the Yangtse on a river steamer and, after meeting Observer D. C. Sowers, on his arrival at Shanghai, took ship for Hongkong, reaching Canton on December 8. Here I immediately prepared the records of observations for transmission to Washington and joined Mr. Sowers in comparison observations between magnetometers C. I. W. No. 2 and No. 10. Dip circle Dover No. 171 and chronometer Arnold and Dent No. 677 were forthwith turned over to Mr. Sowers for his trip across China, and magnetometer C. I. W. No. 2 was shipped to Washington. After another month and a half devoted to college affairs, I sailed from Hongkong on February 8 for America, arriving at New York on April 28, 1909.

The following stations were occupied:

1. Honglok, Kwangtung (reoccupied at end of expedition).
2. Tsingtau, Shantung.
3. Weihsien, Shantung.
4. Tsinan, Shantung.
5. Tsining, Shantung.
6. Hanchwang, Shantung.
7. Taierhchwang, Shantung.
8. Tsinkiangpu, Kiangsu.
9. Chinkiang, Kiangsu.
10. Nanchang, Kiangsi.

Station No. 9 was a reoccupation of No. 11 in Expedition II, 1906.

The total time devoted to this expedition was 2 months and 25 days, of which 20 days were spent in travel to and from the field and in making preliminary arrangements. The total time in the field was 65 days, or an average of 6.5 days per station. Observations were made on 25 days and were prevented on 7 days by bad weather. The actual travel required 36 days, the total distance traversed being 3,405 miles, of which 2,545 were by ocean and river steamers, 220 by rail, 305 by launch, 210 by sailboat, and 125 by cart and on foot (the instruments during this period being carried by coolies). Of the travel by ocean and river steamers, 2,215 was necessary in getting to and from the field; thus the travel in the field, properly speaking, was but 1,190 miles, or an average of 119 miles per station. The

total cost of this expedition, including the travel to and from the field, but exclusive of the observer's salary, was $642, or an average of $64 per station.

Apparently no local disturbances of any magnitude were encountered. Considerable irregularity was found in the behavior of the dip needles and the difficulty of securing accurate observations of dip was increased by the failure of the level bubble due to cracking of the tube, which, however, was replaced by a new tube on December 2 through the courtesy of the Zikawei Observatory.

The missionaries met with, especially those at Weihsien, Tsining, Tsingkiangpu, and Nanchang, besides extending personal courtesies, gave very opportune assistance in securing the necessary means of transport, a very troublesome matter in a country like China, so variable in its local conditions as to travel and with such a variety of dialects.

EXPEDITION VI.—NORTHWARD THROUGH CENTRAL CHINA, FROM THE VALLEY OF THE PEARL RIVER TO THE VALLEY OF THE YANGTSE, JULY TO SEPTEMBER 1911.

The month of September 1910 was spent in Washington comparing theodolite-magnetometer C. I. W. No. 12 and dip circle No. 206 with the adopted standards of the Department. The outward voyage to China was made under the joint auspices of the Department and of the Canton Christian College in the fall of that same year, Canton being reached on December 13. Here the instruments referred to, shipped me from Washington, were received on December 26; these with pocket chronometer Kittel No. 254, Hamilton watch No. 55, and other field accessories, constituted my equipment throughout both this expedition and the next. In March, 9 days were devoted to comparing dip circle No. 206 with the standard of the Hongkong Observatory, and in June, 6 days were devoted to a comparison of theodolite-magnetometer C. I. W. No. 12 with the Hongkong Observatory's standard, Elliott No. 55, and to preparations for the proposed expedition. These Hongkong instruments were the same ones used by me in the Hainan Survey of 1906 (Expedition I).

The present expedition from the valley of the Pearl River, on which Canton is situated, northward through Kwangtung and Kiangsi provinces to the valley of the Yangtse, was undertaken in accordance with instructions dated November 14, 1910. I was accompanied throughout by Mr. Y. K. Ngan, a student at the Canton Christian College, as recorder and assistant observer, he taking the place of Mr. Yue, who had died in April 1911. After devoting the first half of July to exhaustive comparisons of magnetometer C. I. W. No. 12 and dip circle No. 206 with the standards at the Hongkong Observatory, we left Hongkong on July 21 by river steamer and at Canton took a train on that section of the Canton to Hankow Railway which was already in operation. From the railhead, which was about 60 miles up the North River, we went by launch to Shiuchow and thence by houseboat continued the ascent of the North River to Namyung, and from there proceeded on foot to cross the Meiling Pass to Kanchow, at the head of navigation on the Kan River. This river was descended in its northerly course through Kiangsi to the capital, Nanchang, whence by launch we traversed the Poyang Lake and ascended the Jochow River to Wongkong, proceeding thence, also by launch, to Kiukiang, on the Yangtse, from which a side trip was made on foot to Kuling, a summer resort some 4,000 feet high in the Lu Mountains of the Yangtse.

The actual traveling-time required for this overland trip from Canton to Kiukiang was 19 days, not counting stops at the 8 stations occupied *en route*. Leaving Kiukiang on August 30, we descended the Yangtse to Nanking, occupying 3 intermediate stations. From Nanking a side trip was made northward into Anhwei Province to Hwaiyüan by rail and horseback. We then proceeded by rail to Shanghai, stopping at Soochow and Lukiapang, to which the magnetic department of the Zikawei Observatory has been removed. Here comparisons were made with the observatory standards on September 12 to 15. We then took ship at Shanghai for Hongkong and arrived at Canton on September 22, where the rest

of the month was spent on computations and records and on the necessary arrangements for the next expedition.

The following stations were occupied:

1. Hongkong.
2. Honglok, Kwangtung.
3. Yingtak, Kwangtung.
4. Shiuchow, Kwangtung.
5. Namyung, Kwangtung.
6. Kanchow Ki, Kiangsi.
7. Kianfu, Kiangsi.
8. Linkiang (Ho Quan), Kiangsi.
9. Nanchang, Kiangsi.
10. Wongkong, Kiangsi.
11. Kuling, Kiangsi.
12. Kiukiang, Kiangsi.
13. Anking, Anhwei.
14. Tatung, Anhwei.
15. Wuhu, Anhwei.
16. Hwaiyüan An, Anhwei.
17. Soochow, Kiangsu.
18. Lukiapang, Kiangsu.

Station No. 9 was a reoccupation of No. 10 in Expedition V of 1908. Stations Nos. 12 and 15, while at the same river ports, were not identical with Nos. 22 and 4 of Expedition IV, 1907, because, owing to floods, the old stations were under water. New stations were, therefore, chosen in elevated places to avoid this difficulty in the future. Station No. 17, while on the campus of the Soochow University, as was No. 13 of Expedition II, 1906, was not identical with the latter, because in the interval a regrading of the college campus had eliminated the station-marker.

The total time given to this expedition, not counting that given to preliminary arrangements, was 3 months, 21 days of which were devoted to the extended series of comparisons at the Hongkong Observatory already mentioned. Not counting these, and the week spent at Canton in computation at the conclusion of the trip, the total time in the field was 64 days, or an average for the 16 field stations of 4 days per station. Besides the 23 days on which observations were made at Honglok and Hongkong previous to starting out, observations while in the field were made on 20 days and were prevented on but 2 days by bad weather. The time devoted to actual travel was 31 days in the field and 4 days returning from the field. The total travel consisted of 1,180 miles by steamer in returning from the field; and in the field, of 375 by steamer, 225 by launch, 340 by sailboat, 435 by rail, and 70 on foot, or a total of 1,445 miles actually in the field, giving for the 16 field stations an average of practically 90 miles per station. The total cost of the expedition, not counting the extended series of comparisons at Hongkong, exclusive of observer's salary, was $638, or an average of $40 per station. The expenses incurred in connection with the comparisons at Hongkong amounted to about $98, exclusive of the observer's salary.

I was accompanied throughout the overland portion of this expedition by Mr. A. R. Knipp, instructor in physics at the Canton Christian College, who very materially assisted in arranging for the necessary facilities of transportation. Besides the generous assistance afforded by various missionaries, I have again to refer to the efficient help afforded by the Zikawei Observatory, which, in connection with its new magnetic station at Lukiapang, had provided a special stone observing pillar for my use in making comparison observations.

EXPEDITION VII.—SOUTH CHINA COAST, YUNNAN, FRENCH INDO-CHINA, AND SIAM, OCTOBER 1911 TO MARCH 1912.

The first part of this expedition was carried out according to instructions dated November 10 and 14, 1910, and the latter part according to instructions received by cable at Hanoi on December 5, 1911. The instrumental equipment and field outfit were the same as for the preceding expedition and, as before, I was accompanied by Mr. Y. K. Ngan, my assistant.

The original plan of Expedition VII was to ascend the West River across Kwangtung and Kwangsi and from its headwaters to proceed on foot across Yunnan into Burma by way of Bhamo, and, on reaching Rangoon, to return to Canton by sea. On account of an initial delay of several days in the latter part of September and the first few days of October due to sickness, I was deprived of the expected privilege of making the journey across Kwangsi in the company of the Reverend H. O. T. Burkwall, the agent of the British and Foreign Bible Society for that region. Since there were, furthermore, rather insistent

rumors of disturbances in the western part of Kwangsi, I determined to reach the center of Yunnan Province by way of the French railroad from Tonkin. After 2 days of preliminary observations at Honglok (Canton) and 3 days spent on correspondence and arrangements for the expedition, we left Canton on October 9 for Hongkong and there took coasting-vessel to Pakhoi, which was reached on the morning of October 12. Here, through the good offices of Dr. Neville Bradley, of the Church Missionary Society, the steam launch of the taotai at Limchow was put at our disposal for carrying our party along the coast to the boundary between Kwangtung and Tonkin.

We arrived at Chushan on the forenoon of October 17, and, after observing, left that same evening by sailboat for Tunghing, which is the Chinese city just opposite to Moncay, the French settlement at the northeast corner of Tonkin, whence a small coasting-steamer was taken to Haiphong. Arriving there on the 20th, I forthwith conferred with Director Le Cadet, of the Phu Lien Observatory. No magnetic work had thus far been carried on at Phu Lien, so that our observations were very welcome and Director Le Cadet afforded every possible assistance. From Haiphong we proceeded by rail on the 23d to Hanoi and there consulted with the government and railway officials, to whom introductions had been given by the French consul-general at Canton, M. Beauvais. The government very courteously extended the privilege of free transportation on all the railroads throughout French Indo-China, and the engineer-in-chief of the Yunnan Railway did the same for the journey to Yunnanfu. Before proceeding into Yunnan I, therefore, endeavored to occupy as many stations within easy reach of Hanoi as were feasible, and for this purpose made round trips by rail to Vinh, in Annam, and to Langson, in northeastern Tonkin.

Leaving Hanoi on November 4, and, after observing at Yenbay *en route*, we reached Laokai on the night of the 5th. On the morning of the 7th we crossed the border into the Province of Yunnan and proceeded by rail to Posi, which was reached on the forenoon of November 10. On account of severe landslides due to excessive spring rains, we could go no further by rail and at Posi made arrangements for a caravan of donkeys, with the aid of which, by withdrawing from the line of the railroad, we were able to cross the intervening mountains and arrived at Kaokaitseu on the evening of November 14. Thence we proceeded by train to Yunnanfu, arriving on the 15th.

Because of the disturbed state of the Province as a result of the revolution, which had begun since my departure from Canton, and because the reports of trouble on the border between Yunnan and Burma were quite alarming, it was deemed best, in conference with the British and French consuls-general at Yunnan, to abandon the plan to proceed westward; neither was it possible to proceed northward toward the Yangtse for a similar reason. We were forced, accordingly, to return into Tonkin as we had come, and on arrival at Hanoi in the first week of December, we received, in response to a cablegram which had been forwarded from Yunnan through the courtesy of the British consul-general, instructions authorizing an expedition throughout French Indo-China and Siam. Consequently, after re-observing at Phu Lien Observatory, we left Haiphong on December 8 by steamer for Tourane, on the coast of Annam, which was reached on the evening of the 9th, and from there we ascended by rail via Hué to Quangtri, whence, having secured a guide and carriers under the auspices of the French Resident, we started on December 19 westward across Annam and Laos to reach the Mekong River at Savannakhet.

This journey, including just such stops as were necessary for observation at 3 stations *en route*, required 13 days and was accomplished by small boat and on foot as far as Laobao, where canoes were secured in which we descended the Sebanghien to Songkhon. The trip was very trying owing to the intense heat and lack of protection during the day. Progress was also very slow on account of numerous rapids, rendering the unloading and reloading of the canoes necessary several times a day. With the exception of one night, all the nights during this journey were spent in native huts, through the courtesy of the chiefs

of the villages. The people were very hospitable and no difficulty was found in securing food as well as shelter, although the hamlets were very small and not very numerous.

From Songkhon, which was reached on the evening of December 29, we proceeded on foot northwesterly to Savannakhet, arriving there on the morning of January 1, 1912. Thence, through the courtesy of the French Resident Commissioner, we were enabled to ascend the Mekong by small steamer to Vientiane, the capital of French Laos, which was reached on January 9, and, through the courtesy of the Résident Supérieur, who granted transportation and subsistence on account of the government, we descended the Mekong to Stungtreng, in Cambodia, arriving there on January 20. From Stungtreng we continued to descend the Mekong on our own account to Pnompenh and from there by chartering a small launch were enabled to make a round trip northwesterly to Siemreap and Angkor-Vat. On return to Pnompenh we left for Saigon, in Cochin-China, and from there, after making a round trip by rail to Phantiet, we proceeded by sea to Bangkok, in Siam, occupying *en route* the station Hongchong, on the northwest coast of Cochin-China.

Arriving at Bangkok on February 13, we were enabled, through the good offices of the American minister, to secure the cooperation of the Siamese government, and under their auspices spent the rest of the month in occupying stations along all the railroad lines in operation, proceeding northward as far as Mehphuak, in Siamese-Laos, and to Korat, northeast from Bangkok, and southward to Huahin, on the east coast of the Malay Peninsula. Leaving Bangkok by steamer on March 1, I returned to Canton by sea, arriving there on the 11th, and after 2 days spent on computation and correspondence, devoted myself from then on to my duties in connection with the Canton Christian College. On April 8, I left Canton for America by way of the trans-Siberian Railway, and reached New York on May 25, the Department bearing a proportionate part of the necessary homeward expenses.

The instruments and the field equipment were left at Canton to be available on my return, while the chronometers were brought with me to America. The following stations were occupied:

In China (3 stations):
1. Honglok, Kwangtung.
2. Pakhoi, Kwangtung.
3. Chushan, Kwangtung.

In French Indo-China (6 stations):
4. Phu Lien, Tonkin (reoccupied between 13 and 14).
5. Hanoi *A*, Tonkin (no results because of local disturbance).
6. Vinh, Annam.
7. Langson, Tonkin.
8. Yenbay, Tonkin (reoccupied between 13 and 14).
9. Laokai, Tonkin.

In China (4 stations):
10. Mengtsz, Yunnan.
11. Posi, Yunnan.
12. Kaokaitseu, Yunnan.
13. Yunnanfu, Yunnan.

In French Indo-China (21 stations).
14. Hanoi, Tonkin.
15. Tourane, Annam.
16. Hué, Annam.
17. Quangtri, Annam.
18. Laobao, Laos.
19. Tchépone, Laos.
20. Bantacheng, Laos.
21. Savannakhet, Laos (reoccupied between 23 and 24).

In French Indo-China (Continued).
22. Pakhinboun, Laos.
23. Paksane, Laos.
24. Vientiane, Laos.
25. Donsa, Laos.
26. Paksé (*A* and *B*), Laos.
27. Bassac (*A* and *B*), Laos.
28. Stungtreng, Cambodia.
29. Kratié (*A* and *B*), Cambodia.
30. Pnompenh, Cambodia (reoccupied between 31 and 32).
31. Angkor-Vat, Cambodia.
32. Saigon, Cochin-China.
33. Phantiet, Cochin-China.
34. Hongchong, Cochin-China.

In Siam (9 stations):
35. Bangkok.
36. Pitsanuloke.
37. Mehphuak.
38. Lopburi *A* (reoccupied between 41 and 43).
39. Korat.
40. Huahin.
41. Paknampoh.
42. Lopburi *B*.
43. Ayuthia.

So far as I know, these stations in China and in French Indo-China are new. Station *A* in Hanoi, which was located in the Ecole Professionelle, was found to be affected by its proximity to buildings and, consequently, a new station, located in the midst of the large open tract in front of the governor-general's residence, was occupied. In Siam the

station at Lopburi is of special interest, as this place is identical with Louveau, where Guy Tachart, S. J., observed the magnetic declination in 1682. The observations at Lopburi were made at two stations, one in the eastern and the other in the southern section of the ancient palace grounds. The results in Siam show a locally disturbed field, which is also indicated by the few preliminary observations which the Royal Survey Department have thus far secured.

The total time devoted to this whole expedition was 5 months, not counting the 10 days spent in returning to Canton from the field. The total number of stations was 43, giving thus an average of about 3 days per station. The total travel to and from the field was 2,876 miles; while the total travel in the field was 4,059 miles, of which 257 were by ocean steamer, 1,549 by river steamer, 150 by canoe, 75 by launch, and 150 on foot. In China the total travel in the field was 565 miles, in French Indo-China, 2,440, and in Siam, 1,054. Much of the travel in French Indo-China was at the expense of the government, while in Siam the entire transportation expenses were borne by the Siamese government. The average travel in the field per station was about 80 miles in China, 90 in French Indo-China, and 117 in Siam. The total expense of the whole expedition, not counting the observer's salary, was $1,703, of which about $300 was for travel to and from the field and about $250 for the work in China, $928 for that in French Indo-China, and $225 in Siam, not taking into account the value of the transportation and other facilities provided by the respective governments. The average per station for the whole expedition was a little under $40. Observations were made on 63 days and were prevented by bad weather on 10 days.

Besides the assistance afforded by the taotai of Limchow, already referred to, special acknowledgment is due to the résidents supérieurs of Tonkin, Annam, and Laos, for the generous assistance which, under their direction, was afforded by the administrations of their respective provinces, and to M. Chemin Dupontes, engineer-in-chief of the Yunnan Railway, who provided free transportation and an escort on his line, and to Mr. Daniel Brandela, agent of the Standard Oil Company at Tourane. In connection with the work in Siam, special acknowledgment is due to the United States minister, Hon. Hamilton King, and to Hon. Jens I. Westengard, General-Advisor to the Siamese government, on whose advice His Highness, Phya Maha Ammat, vice-minister of the Interior, not only assumed the expenses for transportation of the expedition within Siam but arranged for the entertainment of the party at the various stations occupied and delegated one of his staff, Khoon Arm Phan, as escort and interpreter. It was due to the facilities thus put at my disposal that it was possible, within a fortnight, to observe at so many stations distributed throughout the region accessible by rail.

In connection with the work in China, acknowledgment is due to His British Majesty's Consul-General O'Brien Butler and to Consul-General Wilden, of France, at Yunnanfu, for their assistance and advice in overcoming the difficulties imposed on the expedition by the state of revolution.

H. F. JOHNSTON, ON MAGNETIC WORK IN BRAZIL, ARGENTINA, URUGUAY, AND PARAGUAY, MAY 1913 TO FEBRUARY 1914.

On authority of instructions dated August 13 and October 24, 1912, and April 4, 1913, I was relieved, on May 17, 1913, of duty aboard the *Carnegie* and placed in charge of the land work here reported upon. The instrumental outfit consisted of magnetometer No. 19, chronometers Nos. 1044 and 244, watches Nos. 103 and 107, observing-tent, and accessories.

The following is a list of the stations occupied between May 17 and December 25, 1913, at which date I left on my return to Washington:

1. Vassouras (*A* and *B*), Brazil.
2. Florianopolis, Brazil.
3. Sao José do Norte, Brazil.
4. Rio Grande, Brazil.
5. Pilar (1, 8, *B*, and *C*), Argentina.
6. Victoria, Argentina.
7. Montevideo, Uruguay.
8. Colon, Uruguay.
9. Punta del Este, Uruguay.
10. Melo, Uruguay.
11. Treinta y Tres, Uruguay.
12. Cerro Colorado, Uruguay.
13. Mercedes, Uruguay.
14. Durazno, Uruguay.
15. Rivera, Uruguay.
16. Tacuarembo, Uruguay.
17. Concordia, Argentina.
18. San Eugenio, Uruguay.
19. Itaquy, Brazil.
20. Monte Caseros, Argentina.
21. Mercedes, Argentina.
22. Saladas, Argentina.
23. Trinidad, Paraguay.
24. Sapucay, Paraguay.
25. Villa Rica, Paraguay.
26. Yegros, Paraguay.
27. Encarnacion, Paraguay.
28. Cahi Puente, Paraguay.
29. Posadas, Argentina.
30. Puerto Britannia (*A* and *B*), Brazil.
31. Puerto Aguirre, Argentina.
32. Piray, Argentina.
33. Yaguarazapa, Paraguay.
34. Ituzaingo, Argentina.
35. Ita-Ybate, Argentina.
36. Itati, Argentina
37. Corrientes, Argentina.
38. Villa del Pilar, Paraguay
39. Formosa, Argentina.
40. Villa del Rosario (Puerto), Paraguay.
41. Concepcion, Paraguay.
42. Puerto Pinasco, Paraguay.
43. Murtinho, Brazil.
44. Barranco Branco, Brazil.
45. Porto Esperança, Brazil.
46. Bahia Negra, Paraguay.
47. Corumbá *B*, Brazil.
48. Corumbá *A*, Brazil.

Of the above, Nos. 5 and 6 were repeat stations of the Department, Nos. 1, 2, 3, 19, and 47 were repeat stations of the Brazilian service, Nos. 17, 21, 29, 30, 31, 34, and 37 were more or less exact reoccupations of repeat stations of the Argentine service, and Nos. 7 and 8 were repeat stations of other services. The itinerary of the work was as follows:

On being relieved from the *Carnegie*, I proceeded to Rio de Janeiro, where comparisons with the instruments of the Brazilian survey were secured at Vassouras. Two stations were occupied *en route* from Rio de Janeiro to Buenos Aires, travel being by coasting-steamers which run each week and call at all the small ports on the coast. Intercomparisons were then made at the Pilar Magnetic Observatory and the repeat station of Victoria near Buenos Aires was reoccupied. Then I observed at Montevideo and distributed 9 stations, as equally spaced as possible, along the railroad lines of Uruguay. The train service was a uniform one of three times a week on all the lines.

After completing the work in Uruguay, I occupied one station in Brazil and 4 stations in the province of Corrientes on the northeastern Argentine railway. I proceeded then to Asuncion, occupying one station at Trinidad and afterward 4 stations along the line of the Paraguay Central Railway. I next occupied on the Alto Paraná, 9 stations, distributed with fair uniformity between Puerto Britannia, the limit of navigation, and Corrientes at the mouth of the river. Travel on this river was by small river steamer, there being on the average two each week. After leaving Corrientes, I occupied 9 stations while traveling up the river Paraguay. On reaching Corumbá, Brazil, I found that unfortunately the rainy season had commenced. Accordingly, field work was closed and on December 25 I left Corumbá, arriving in Washington February 3, 1914.

The total time spent in the field was 263 days, which, counting in all delays, gives an average field time per station of 4.5 days. The total travel approximated 14,600 miles, 9,000 miles of which were travel to and from the field. The field travel consisted of 2,200 miles by river boat and 3,400 miles by railroad, thus making the average field travel per station 117 miles.

In general there was very little local disturbance; the only region where it was anyway marked was on the Alto Paraná.

Cordial assistance was rendered by the American consuls in the various countries visited. In Brazil, Dr. Morize secured passes and permission for a telegraphic signal and Ambassador Edwin Morgan obtained letters of introduction. In Argentina, Dr. Davis, director of the Meteorological Service, was of invaluable assistance, and through the courtesy of the Director of Telegraphs I obtained 4 time signals from Cordoba. In Uruguay, Mr. Bassano, head of the Meteorological Service, secured letters of introduction to officials in the various towns visited. In Paraguay the Minister of Foreign Relations gave very valuable assistance.

E. KIDSON, ON THE GENERAL MAGNETIC SURVEY OF AUSTRALIA, 1911 TO 1913.

The general magnetic survey of Australia, which will be practically completed by the end of 1914, was begun the middle of July 1911, the plan followed being that contained in the Director's instructions of June 21, 1911, and subsequent supplementary ones. Quoting from the Director's article in the September 1911 issue of *Terrestrial Magnetism and Atmospheric Electricity*, page 215:

"Australia is at present (1911) the largest land area in which so comparatively few magnetic observations have been made. With the exception of the portion of Victoria, of which a magnetic survey embracing about 235 points was carried out by the indefatigable Neumayer, between 1858 and 1864, the preliminary magnetic survey of Tasmania by McAulay and Hogg in 1901, and some isolated observations along the coasts, such magnetic results as exist in the interior are confined, well-nigh exclusively, to compass observations by surveyors.

"If it be remembered that the total area involved is over three-fourths that of entire Europe, and is practically equal to that of the United States (exclusive of Alaska), it will readily be appreciated that there remains here an important field for magnetic exploration. And the importance does not arise merely from purely scientific considerations, but from practical ones as well—navigation, surveying, and exploration of the great interior reaches. The prevalence of local disturbances at some of the ports of call is well known, and mention should be made here of the remarkable local disturbances revealed at Port Walcott on the northwest coast, by the admirable work of H. M. S. *Penguin*, 1890–93."

As the result of the Director's conferences with various government officials and men of science at Sydney, Melbourne, Adelaide, and Perth, in May and June 1911, the much desired general magnetic survey of Australia was organized, the Melbourne Magnetic Observatory, under the direction of Professor Baracchi, serving as the principal base-station throughout. The writer, at Colombo, Ceylon, on June 21, 1911, was relieved of ocean duty aboard the *Carnegie*, and was placed by the Director in charge of the proposed survey, serving throughout the work in this capacity. The total expenses of the work have been borne by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The cordial assistance received at all times from government authorities and from others too numerous to mention by name, deserves mention and is here gratefully and appreciatively acknowledged. The thanks of the Department are especially due Professor Baracchi for looking after the forwarding of the mail to the observers in the field and for facilitating the work in many ways.

The general plan was for the Department of Terrestrial Magnetism to observe the magnetic elements, with every precision possible, at stations spaced, on the average, about 100 miles apart, *i. e.*, about 1 station to every 10,000 square miles. As the area of Australia and outlying possessions is practically 3,000,000 square miles, a general magnetic survey would imply 300 stations; there were 394 different stations at the end of 1914. Up to the end of 1913 there had already been 247 stations; during 1914, 3 additional observers were assigned, so that 4 parties could be put in the field. The detailed work, it is hoped, will be undertaken by the Commonwealth itself or by interested persons.

It is not necessary in this general report to enumerate the stations up to the end of 1913, since they will all be found tabulated in the "Table of Results, pp. 36–42." A summary of preliminary values of the magnetic elements was presented before the Australasian Association for the Advancement of Science at the January 1913 meeting in Melbourne and printed in the Report of the Association, Vol. XIV, pp. 20–23.

Those, besides myself, engaged in the work here described, were: E. N. Webb, temporary observer, July to October 1911; F. W. Cox, assistant observer, May 1912 to February 1913; F. Brown, assistant observer, July to December 1913.

The distribution of the instrumental outfits used during the several years is indicated in the following paragraphs.

1911.—July to August: magnetometer No. 9; magnetometer No. 6; Barrow dip circle No. 41 (loaned by courtesy of the Director of the Melbourne Observatory); chronometers Nos. 252, 253, and 258; watches Nos. 52, 107, 137, and 400; and accessories. September to December: magnetometer No. 17; dip circle No. 178; chronometers Nos. 252 and 258; watches Nos. 107 and 137. Mr. Webb's equipment, August 29 to October 25, consisted of magnetometer No. 9, dip circle No. 41, chronometer Kittel No. 252, watches Nos. 52 and 400, and accessories.

1912.—Magnetometer No. 17; dip circle No. 172; pocket chronometer No. 258; watches Nos. 107, 137, and 400. From September 27 to the end of year also chronometer No. 251.

1913.—Until September 13: magnetometer No. 17; dip circle No. 172; chronometer No. 258; watches Nos. 107, 137, and 400; and accessories. From September 29 to December 1: magnetometer No. 6; Barrow dip circle No. 41, of the Melbourne Observatory; chronometer No. 251; watch No. 137. For balance of the year: universal magnetometer No. 14; chronometers Nos. 251 and 253; and accessories.

Comparisons of the instruments used have been made from time to time, both in the field and at the principal base-station, Melbourne. Also as occasions presented, special declination readings, in addition to the usual magnetic observations, were made at close intervals, and for as long periods as circumstances permitted. For the control of the secular changes, repeat stations have been established which were reoccupied whenever possible.

The work during 1911 was in Victoria, South Australia, and New South Wales and Tasmania. The Department in fulfillment of its promised aid to the Australasian Antarctic Expedition, employed Mr. E. N. Webb, of Christchurch, New Zealand, as temporary observer, from July to November 1, in order that he might secure under me the desired training in magnetic work before joining the expedition. Later Mr. A. L. Kennedy, who also was to be one of the observers of the expedition, was given the necessary instruction. Both observers were especially trained in the use of the two complete outfits, loaned the expedition by the Department, for magnetic-survey work. It was understood that the requisite training in the magnetic-observatory work would be received by them at the Melbourne Observatory. The Department's cooperation was to cover only the needs of the field work of the expedition. The instruments used were carefully intercompared at Hobart, Tasmania, in December 1911, and again in Melbourne in 1913 upon the return of Messrs. Webb and Kennedy from the Antarctic.

The 1912 operations were in Western Australia, the remarkable local disturbance at Mount Magnet receiving some attention; observations were secured at 24 stations. The transcontinental trip, from south to north—Adelaide to Port Darwin—was next organized (see synopsis below). Upon completion of the work at Port Darwin, I sailed on October 4 for Melbourne, observing *en route* at Thursday Island, making here special magnetic observations, in accordance with the Director's instructions, on October 10, 1912, on which date occurred a solar eclipse. I then continued the work, with Mr. Cox's assistance, in north Queensland. Eleven stations were established by the early part of December, when the party proceeded to Melbourne. During the remainder of December, 5 stations were occupied in the southwestern portion of Victoria.

In 1913, the work up to the end of June was done in Victoria and in New South Wales. In the course of this work there were reoccupied the British Admiralty station at Garden Island, Sydney, and the Red Hill branch station of the Sydney Observatory, where an intercomparison with the observatory magnetometer was made. In April, in company with Mr. E. N. Webb, of the Australasian Antarctic Expedition, an intercomparison was obtained between the observer's outfit and magnetometer No. 6 and Lloyd-Creak dip circle No. 169 returned by the expedition. A satisfactory distribution of stations in New South Wales was obtained; a number of less easily accessible stations in the very sparsely occupied western portion being reached by automobile.

Early in July I proceeded to Melbourne, where Mr. Frederick Brown joined the party as assistant observer. Proceeding to Brisbane, the work in Queensland was begun. Until the end of August the party was engaged on the work in southwest Queensland, along the railway lines and on a motor trip of 1,000 miles in the far west over rough country. Mr. Brown, after gaining experience by occupying 3 coastal stations, undertook the long journey by automobile of over 2,000 miles along the western border of Queensland and into the Northern Territory, as narrated in his own report. I meanwhile, with our magnetometer No. 6 and the dip circle loaned by Melbourne Observatory, occupied a number of stations in the central and coastal portions. During November, I proceeded north along the coast to Townsville and along the Northern line to Cloncurry and then 100 miles north thereof, securing 6 new stations and a reoccupation of our station at Townsville. At the end of the month a station at Brisbane University was occupied and a 24-hour continuous set of declination observations was made. I then traveled south in December and reoccupied 2 stations of the Magnetic Survey of Tasmania and also secured one new station in Tasmania. At the end of 1913 I was thus working in Tasmania and Mr. Brown was traveling south to join me there. For an account of the latter's work during the period, November to December, see his separate report.

E. KIDSON, ON THE MAGNETIC WORK DURING THE TRANSCONTINENTAL TRIP IN AUSTRALIA, MAY TO SEPTEMBER 1912.

Together with Mr. Cox, whom I had appointed as temporary assistant, I arrived at Adelaide from Perth on May 16. As much information and advice as possible with regard to the nature of the overland route and the outfit needed was gathered before we left Adelaide on May 22. Mr. W. Fisher, who, at my request, had been given leave, by the Surveyor-General of South Australia, was appointed camel man. We arrived at Oodnadatta on May 24, and were met by Mr. F. H. Marsh, from whom I had arranged to hire camels for the expedition. Stores were purchased, the camels were inspected, a black boy was secured, and the remaining gear was got together. Opportunity was taken to reoccupy the Oodnadatta magnetic station. Though taking what we anticipated would be sufficient provisions, with the exception of meat, for the whole journey to Pine Creek, we had permission, through the courtesy of the Deputy Postmaster-General of South Australia, to purchase stores from the various stations of the "Overland Telegraph;" we availed ourselves of this privilege on several occasions later. All gear was carefully weighed, and distributed so as to make the two pack-boxes of each pair, forming a camel load, of equal weight. One pair of boxes was reserved for instruments and personal gear; two 20-gallon water kegs formed another load; cooking-utensils and provisions for current use, another; while the remaining stores made up 2 more.

All being in readiness, on May 29 the 5 pack-camels were loaded and strung together; Mr. Cox and I bestrode our strange mounts; the black boy took the lead with a riding camel noted for its even pace; and, in the presence of a large proportion of the inhabitants of the township, we set out northward at $3^h\ 20^m$ p. m. Our 8 camels were all well-seasoned to the work and by nightfall we arrived at our first camp, 12 miles from Oodnadatta. During the first hundred miles of the journey we passed through a district which was suffering from a severe and protracted drought, wide stretches of stony plain almost devoid of vegetation being occasionally met with. The barren areas were varied by sandy creek beds lined with Eucalypti of various species, by patches of scrub, and by low-lying saltbush plains. The scrub consisted generally of mulga, or wattle, for the most part edible by camels. Saltbush is a very nourishing, edible shrub of great drought-resisting properties. Occasionally isolated hills or low stony ridges varied the monotony of the plains. Each morning at the first sign of light the black boy set out to track the camels and bring them in while Fisher cooked breakfast. Breakfast over and the camels arrived, all hands assisted

in the loading and a start was made as soon as possible. We generally got under way at from 9^h to $9^h\ 30^m$ a. m., and traveled, on the average, about 17 miles during the day at a pace varying from $2\frac{1}{2}$ to 3 miles per hour. Lunch, consisting of a few sandwiches, was eaten on the march, so that, except for occasional adjustment of the loads, there were no stoppages till camp was reached.

Magnetic stations were established in general at alternate camps, the average distance apart being thus about 35 miles. By observing in the evenings and early mornings we avoided delaying progress. The water, obtained usually at alternate camps, came from artesian bores in a few cases during the earlier stages; wells of varying depths were, however, the general source, though varied occasionally by natural water-holes which became more prevalent as the northern portion of the route was reached. The water was often highly mineralized, sometimes being to us undrinkable. Game was scarce, but at night-time we were continually visited by dingoes (wild dogs), which, as their tracks showed in the mornings, came noiselessly to within a few feet of our beds.

On June 3, we passed through Dalhousie cattle station. This station is remarkable for possessing a large number of springs, the water varying in temperature and purity in different ones. The store at Blood's Creek, 100 miles from Oodnadatta, was passed on June 6. Near here we engaged another blackfellow. The first telegraph station, at Charlotte Waters, was reached on June 7. We were welcomed by Mr. Kiernan, the officer who was in charge. At all telegraph stations we secured telegraphic time-signals from the Adelaide Observatory. After leaving Charlotte Waters the condition of the country improved, feed became plentiful, and the tracks of kangaroo and of other game were seen.

On June 11 we camped near Crown Point station on the bed of the Finke, a river which rises in the heart of Australia and empties into the Great Lake Eyre. Though dry for the greater part of the year the Finke is a noble river when in flood, and its huge bed and wide gorges point to a more glorious past. Some distance from our camp at this place there were assembled upwards of a hundred blackfellows holding a "bone-breaking corroboree." The main ceremony centers round the breaking of the bones of a man who has been dead for a year, the object being to release his spirit. The festivities last sometimes as long as a month and each evening some form of "corroboree" is given. Mr. Cox and I visited one of these. It was somewhat in the nature of a theatrical entertainment, several performers, in turn, going through a weird dance to the tune of a chant by the audience; excellent lighting effects were produced by means of fires of half-dried gum-tree leaves.

The hotel and store at Horseshoe Bend was reached on June 13. Next day we had fifteen miles of traveling over very high and steep, moving sandhills, the only ones on the whole journey. Here the camel-feed was very poor, though there was a fair amount of vegetation consisting chiefly of spinifex, a coarse spiky grass growing in tall hummocks. While on the march we occasionally met camel-trains, or droves of horses or cattle bound for the southern markets. Our meat supply, usually consisting of salt beef, was replenished at the small stores, cattle stations, or telegraph stations we passed.

On June 20, we arrived at Alice Springs telegraph station, 330 miles from Oodnadatta, where we were most hospitably entertained till June 25, by Mr. McKay, the postmaster, and his wife. Alice Springs is in the Macdonnell Ranges, which consist of masses of quartzite thrown up by an intrusion of granite. Numerous rivers, evidently older than the mountains, rise on the north side of the ranges and pass through level "gaps" to the south side. As the ranges rise as high as 3,000 feet above the surrounding plains, some fine scenery is produced. There is very rich feed in the Macdonnell Ranges and excellent horses are bred in them; game is also plentiful.

From Alice Springs we deviated 70 miles to the east to a moribund goldfield at Arltunga. Returning to the telegraph line at Burt Well we proceeded through fair country to Barrow Creek telegraph station, 175 miles from Alice Springs, situated in a gorge among flat-topped

hills. The day before arriving we were held up by rain. We had also had rain at Alice Springs, but no considerable fall was again experienced till after leaving Katherine, at the northern end of the overland line. Mr. Scott, in charge at Barrow Creek, gave us quarters at the station during our stay and was most kind. Between Barrow Creek, which we left on July 18, and Tennants Creek, the country is varied in character. At one place there is a spinifex-covered plain 30 miles wide without any vegetation suitable for feed, while later among some curious, rounded, granite blocks called "The Devil's Marbles" occurs a plant which is virulently poisonous to stock.

Tennants Creek, 150 miles from Barrow Creek, was reached on July 25 and the hospitality typical of the "Overland Telegraph" was met with at the hands of Mr. Dixon, the postmaster. On July 29, Banka Banka, 60 miles from Tennants Creek, was reached. Here there was a large congregation of blackfellows and an important "corroboree" was in progress. We were able to see several minor celebrations in which dances illustrative of travel and the chase were performed.

The stretch of 120 miles between Tennants Creek and Powell's Creek was covered by August 2. At Renner Spring on August 1 we had encountered a drover who, accompanied by only two blacks, had been traveling south with 100 horses but had been seized with a severe attack of malarial fever and was in a very bad condition. After our arrival, under the stimulus of white company and a little nourishment, he improved, and after getting word of his plight through to Powell's Creek we were able to leave him. Kind treatment was again met with at Powell's Creek, where Mr. Kennedy was in charge of the telegraph station.

Leaving Powell's Creek on August 6, we arrived at Newcastle Waters on August 8; our stay here was made pleasant by Mr. S. Y. Smith, the storekeeper. We resumed the journey on August 10, accompanied by Mr. Macgregor Knox, who had requested to be allowed to travel with us from Newcastle Waters. Daly Waters telegraph station, 150 miles from Powell's Creek, was reached on August 15. Since leaving Tennants Creek we had found the camel-feed getting poorer and scarcer, while poison bushes became prevalent, but, though accounts of the track ahead were conflicting, we had still hoped to be able to get through with the camels to Pine Creek. By the time Daly Waters was reached, however, the camels were becoming poor in condition; at this station one of them was poisoned and had to be shot. It thus became obvious that a change in plans was necessary. After a series of consultations, Mr. Holtze, the officer who was in charge of the telegraph station, promised to lend horses and a dray, the only vehicle available, with which we could continue the journey if the necessary permission were first obtained from Mr. Waddy, the Deputy Postmaster-General, in Adelaide; this permission was courteously granted. I, therefore, immediately sent the camels back to Oodnadatta in charge of Mr. Fisher. As a number of repairs had to be made to the dray it was August 21 before Messrs. Knox, Cox, and myself were able to leave Daly Waters. A week of hard work and considerable anxiety followed. In this part of the country it is necessary to rest horses during the hottest part of the day and to have several changes of horses available. We found that only one pair of our horses would pull the dray and even these horses required careful management. Consequently we had to walk for the greater part of the time and were frequently compelled to move the whole outfit by main force to get the horses started. As our progress was slower than anticipated we had to go on short rations of food. In this country 2 days without water is usually sufficient to cause a man to succumb, and more than 2 days without water will kill horses. The weather was very hot and there was one dry stage of 40 miles. The probability of our having to abandon the dray and outfit and save ourselves was imminent for several days. However, we managed to pull through to Elsey Creek (100 miles), where we were fortunate enough to find a station manager a long way from his usual base, putting up fences. He kindly supplied us with more horses and food, so that from there to Katherine we progressed more easily.

Mr. Holtze, in charge at Daly Waters, entertained us most hospitably while we were there and provided us most liberally with food from his own supply. Stores are sent to these stations only once a year, so that it is difficult to replace any. He was also very kind, as above noted, with regard to the dray and horses, giving us the best available at some risk of inconvenience to himself. At Katherine I met the Administrator of the Northern Territory and had several conversations with him. Through his good offices every courtesy was shown the expedition by officials here and at Batchelor and Port Darwin.

From Katherine we traveled by the weekly mail-coach to Pine Creek, arriving on September 9. On this trip I had my only indisposition, a "touch of sun," I think, which made me feel very sick for several days. From Pine Creek, Port Darwin was reached by railway on September 17. I occupied one station on the coast to the east of Port Darwin, taking advantage of permission to accompany a launch trip organized by the Government. On October 1, a continuous 24-hour set of declination observations for diurnal variation was completed at Port Darwin.

Between Oodnadatta and Port Darwin, 39 magnetic stations were established at an average distance apart of about 35 miles. Very little local disturbance is indicated by the magnetic results, the total range in declination being less than one degree. Stars were used to a considerable extent for the astronomical observations. Dip circle No. 172 was found somewhat troublesome, first one needle then another developing a large correction.

A. D. POWER, ON MAGNETIC WORK IN PERU, ECUADOR, PANAMA, VENEZUELA, COLOMBIA, WEST INDIES, BRAZIL, AND BRITISH GUIANA, JUNE 1912 TO DECEMBER 1913.

The work reported on below was done in accordance with the instructions of June 27, 1912, October 11, 1912, and August 4, 1913. The instrumental outfit consisted of magnettometer No. 16, dip circle No. 177, observing-tent No. 21, pocket chronometer No. 257, small box-chronometer No. 677, Howard watches Nos. 804 and 811, and accessories. At Caracas instruments No. 16 and No. 177 were replaced by the universal magnetometer No. 21, intensity needles Nos. 19 and 20 being used as regular dip needles. Also watch No. 804 was replaced by No. 103.

Leaving Washington and New York on June 29, 1912, I arrived at Mollendo, Peru, via Panama, on the following July 19, where I reported to the chief of party, Mr. J. P. Ault. At Arequipa I received my instrumental outfit and spent several days there, receiving instruction and taking part in the intercomparisons of instruments. My actual field work began at Mollendo on August 1.

Nos. 1 to 15, inclusive, of the following complete list of stations, were occupied while I was a member of Mr. Ault's party. Thereafter, in accordance with instructions, I proceeded as an independent party.

	1912.
1. Mollendo, Peru	Aug. 2.
2. Chala, Peru	Aug. 5.
3. Ica, Peru	Aug. 10.
4. Pisco, Peru	Aug. 8, 13.
5. Huacho, Peru	Aug. 18.
6. Lima, Peru	Aug. 21.
7. Chimbote, Peru	Aug. 26.
8. Trujillo, Peru	Aug. 29.
9. Ascope, Peru	Sept. 1, 2.
10. Chilete, Peru	Sept. 7.
11. Pacasmayo, Peru	Sept. 5, 9.
12. Chiclayo, Peru	Sept. 13.
13 Piura, Peru	Sept. 19.
14. Paita, Peru	Sept. 22.
15. Esmeraldas, Ecuador	Oct. 10, 11.
16. Colon, Panama	Oct. 25.
17. Caracas, Venezuela	Nov. 7-10.
18. Turmero, Venezuela	Nov. 16.
19. Puerto Cabello, Venezuela	Nov. 19.
20. Aroa, Venezuela	Nov. 23.
21. Barquisimeto, Venezuela	Nov. 26.
22. Tocuyo, Venezuela	Nov. 29.
23. Carache, Venezuela	Dec. 4.
24. Trujillo, Venezuela	Dec. 9.
25. Sabana de Mendoza, Venezuela	Dec. 14.
26. La Ceiba, Venezuela	Dec. 17.
27. Maracaibo, Venezuela	Dec. 20.
28. Puerto Villamizar, Colombia	Dec. 26.

	1913.
29. Willemstad, Curaçao Island	Feb. 3, 4.
30. Barcelona, Venezuela	Mar. 28.
31. Cumana, Venezuela	Apr. 1.
32. Carupano, Venezuela	Apr. 7.
33. Port of Spain, Trinidad	Apr. 17.
34. Pedernales, Venezuela	May 28, 29.
35. Tucupita, Venezuela	May 30, 31.
36. Barrancas, Venezuela	June 1.
37. San Felix, Venezuela	June 3.
38 Ciudad Bolivar, Venezuela	June 5.
39. Moitaco, Venezuela	June 12.
40. Mapire, Venezuela	June 13.
41. El Tigre, Venezuela	June 14.
42. Las Bonitas, Venezuela	June 15.
43. Caicara, Venezuela	June 17, 18.
44 Casimirito, Venezuela	June 20.
45. La Urbana, Venezuela	June 21.
46. Santa Maria, Venezuela	June 23.
47. Zamuro, Venezuela	June 26, 27.
48. Maipures, Venezuela	July 1.
49. Marida, Venezuela	July 4.
50. San Fernando de Atabapo, Venezuela	July 7, 8.
51. Baltazar, Venezuela	July 11.
52. Yavita, Venezuela	July 14.
53. Comunidad, Venezuela	July 20, 21.
54. San Carlos, Venezuela	July 23, 24.
55. Cucuhy, Brazil	July 27, 28.

	1913.
56. San Marcelino, Brazil	July 30, 31.
57. San Felipe, Brazil	Aug. 2.
58. Umantuba, Brazil	Aug. 4.
59. Santa Isabel, Brazil	Aug. 6.
60. San Joaquim, Brazil	Aug. 8.
61. Sant Anna, Brazil	Aug. 10.
62. Barcellos, Brazil	Aug. 11.
63. Menena, Brazil	Aug. 12.
64. Inajatuba, Brazil	Aug. 13.
65. Ayrao, Brazil	Aug. 14.
66 Taupeçaçu, Brazil	Aug 15.
67. Manaos, Brazil	Sept. 17.
68. Caracarahy, Brazil	Oct. 6.
69. Allianca, Brazil	Oct. 7.
70. Santa Maria, Brazil	Oct. 9–11.
71. San Francisco, Brazil	Oct. 15.
72. Campiña, Brazil	Oct. 23, 24.
73. Boa Vista, Brazil	Oct. 28.
74. Fazenda "Porre," Brazil	Nov. 1.
75. Sauri-Wau River, British Guiana	Nov. 6.
76. Dadanawa, British Guiana	Nov. 10.
77. Yupukarri, British Guiana	Nov. 18.
78. Apotori, British Guiana	Nov. 23.
79. Siparuni River Mouth, British Guiana	Nov. 27, 28.
80. Rockstone, British Guiana	Dec. 2.
81. Wismar, British Guiana	Dec. 3.
82. Georgetown, British Guiana	Dec. 5, 6.

All the Peruvian stations except Nos. 3, 5, 9, 10, and 13 were reached by steamer, the excepted ones being along the railway. Steamers between Peruvian ports are frequent, but this is not true for Ecuador, all ports except Guayaquil having only fortnightly service. Because of the necessity of reaching Esmeraldas, Ecuador, in time for the total eclipse of the sun on October 10, 1912, this point being in the path of totality, it was found to be impossible to occupy all the stations assigned in the original instructions. After several aggravating delays, I arrived by sailboat at Esmeraldas on October 7. Having made the desired observations, I left on October 12 and, upon arrival at Panama, had to spend several days in quarantine. *En route* to Caracas the station at Colon was reoccupied. Next the trip through Western Venezuela was undertaken on November 15, which was interrupted the latter part of December by an attack of fever. As soon as I had sufficiently recovered from the fever, return was made to Maracaibo and Caracas, occupying a station at Curaçao Island *en route*. While getting back to normal health, the time was occupied with computations, obtaining maps, letters, and all available information concerning the proposed trip from Trinidad to Manaos via the Orinoco River and the Rio Negro.

Leaving Caracas on March 26, the stations Barcelona, Cumana, and Carupano were occupied *en route* to Port of Spain, Trinidad, which was reached on April 12. These stations were reached by steamer, except for a short railway trip from the coast port of Guanta to Barcelona. At Port of Spain the station established by the Department in 1905 was reoccupied and then all attention was given to completing plans and preparations for the next trip.

Leaving Port of Spain on May 27, 1913, by launch, we arrived at Macuro, Venezuela, on the same day, where we passed customs inspection and secured the necessary credentials. The trip across the Gulf of Paria was begun early the next morning and, after passing through two severe squalls, Pedernales, where the first station of the trip was established, was finally reached. Ciudad Bolivar, the fifth station, was reached on June 4. After some delay, the journey up the river was continued on June 11, arriving at Caicara on June 17. Here a day was lost in removing a broken rudder-shoe and replacing it by an improvised one. Zamuro, the port of Atures, was reached on June 26, and the launch was then sent back to Trinidad. Owing to the fact that a revolution of uncertain character was in progress in the territory between Zamuro and the Brazilian frontier, the trip up from Ciudad Bolivar had been attended with considerable worry. There was serious question as to the advisability of touching Zamuro, although a failure to do so meant the abandonment of the trip and an immediate return to Trinidad. The colonel-in-command of the revolutionary forces

courteously provided me free transportation as far as Cucuhy, on the Brazilian frontier, which was reached on July 26, the trip being made via the 12-mile Yavita-Pimichin portage. From the frontier to Sant Anna, about 100 miles below Santa Isabel, transportation was secured on small boats, launches, and steamers. At Sant Anna a launch was obtained for the remainder of the trip on down to Manaos, where I arrived on August 16, 1913.

Following supplementary instructions received at Manaos, the trip to Georgetown, British Guiana, was begun on October 1, and passage was engaged on launches as far as Boa Vista on the Rio Branco. A canoe was used to reach Fazenda "Porre" and the next two stations were reached on foot, the outfit being transported by ox-cart. At Dadanawa, passage for the difficult trip down river, through the rapids to Rockstone, was secured on a large boat paddled by Indians. Wismar was reached by railway and Georgetown by river steamer on December 4. Here the field work was closed. Leaving Georgetown on December 6, I reported at Washington on December 18, 1913.

The total time consumed on the above work was from June 29, 1912, to December 18, 1913, or 538 days. Deducting the time spent in travel to and from the field, making arrangements, loss due to sickness, and various delays, in all 219 days, there are left 319 days of actual field work, or an average of 3.9 days per station. The travel to and from field totaled about 6,730 miles, while travel in field amounted to about 8,970 miles, making a total of 15,700 miles. This averages 192 miles total travel per station, or 109 miles field travel per station. This last includes the trip of about 1,900 miles from Guayaquil to Caracas with 2 stations *en route*, and the 490 miles round trip from Maracaibo to Cucuta with 1 station. Counting out these distances, the field average is about 84 miles per station. The distances covered in the field by the various means of transportation were approximately as follows: sailboat, 430 miles; railway, 705 miles; handcar, 65 miles; canoe, 700 miles; coach, 40 miles; muleback, 110 miles; on foot with ox-cart, 90 miles; launch, 2,600 miles; steamer, 4,230 miles.

No very marked local magnetic disturbances were noted along the west coast, although the sand which occurred everywhere had a very large percentage of magnetite. There appears to be some local disturbance near Mapire on the Orinoco River and a much larger disturbance near San Carlos on the upper Rio Negro.

During the whole trip I was received, almost without exception, with the greatest kindness and courtesy. The American diplomatic and consular officers rendered much assistance. The Minister of Interior, both of Peru and Venezuela, furnished valuable letters of introduction to their local officials, regarding free entry of instruments, etc. The government of Ecuador instructed its officials at Esmeraldas to render every assistance possible during the special eclipse observations. In the course of the work along the western coast, the managers of the various offices of the Central and South American Telegraph Company were always ready to obtain time-signals and to render other valuable assistance. Owing to their great number, it is impossible to mention by name the many officials and private individuals who extended required aid.

H. R. SCHMITT, ON MAGNETIC WORK IN PERU, MAY TO AUGUST 1912.

The following work was executed according to instructions received from the chief of party, Mr. J. P. Ault, dated Tarma, May 22, 1912. The instrumental outfit consisted of magnetometer No. 8, dip circle No. 171 provided with 4 dip needles, marine chronometer No. 1044, and watches Nos. 53 and 100.

The stations at which magnetic observations were made are:

Station	1912.	Station	1912.
1. Tarma	May 23.	7. Platanos	June 29, 30.
2. La Merced	June 4.	8. Baños	July 5.
3. Eneñas	June 9, 10, Aug. 11.	9. Honoria	July 7.
4. San Nicolas	June 14, 15.	10. Masisea (A repeat station, previously occupied by C. C. Stewart, October 1910.)	July 14, 20, 21, 22.
5. Puerto Bermudez	June 21, 22, Aug. 4, 5.		
6. Puerto Victoria	June 26.		

After observing at Tarma on May 23, the trip on mule-back was started on the 24th to Palca, where a stop was made to allow the arriero to outfit for the trip. On the 25th Huacapistana was reached. As it was found that chronometer No. 677 had stopped during the trip, it was replaced on May 31 by chronometer No. 1044. The journey was continued the following day to La Merced, where I observed on June 4. It may be noted here that the trail from Tarma to La Merced is an excellent one, and all down grade, while beyond La Merced it is not so good and mules are mired in the mud and water. Because of this bad portion of the trail it is necessary to load the mules light, between 150 and 200 pounds. In the wet season the trail becomes well-nigh impassable. After various vicissitudes and delays because of bad weather, Puerto Yesup, on the Pichis River, was reached June 17, magnetic observations having been secured *en route* at 2 stations. From the preceding statement it figures out very closely that, when the trail is good, the pack-train can do a league (3 miles) an hour, while, when the trail is bad, as it generally is, it takes the pack-train an hour and a half for a league.

Proceeding next by canoe, I arrived at Puerto Bermudez June 20 and completed my observations on the 2 following days. At Puerto Victoria, where the Pichis and Palcazu join to form the Pachitea River, observations were made on June 26, and at Platanos on the 29th and 30th. After various delays by heavy rains, the river rising 5 feet, Masisea, C. C. Stewart's station of 1910 on the Ucayali River, was reached and reoccupied July 14, observations having been made besides at 2 stations *en route.* On the swift rivers like the Pichis, Pachitea, and Ucayali, near Masisea, it takes, by canoe or launch, twice as long to go up as to come down. The trip from Puerto Bermudez to Masisea requires 10 to 11 days by canoe, and 3 to 4 by launch; the return trip takes 20 to 22 days by canoe, and 6 to 8 by launch. A magnetic station was established at Tushmo above Masisea, July 20 to 22. On the 23d I returned by launch to Masisea. From July 24 to August 3 the journey was continued on the launch *Rosa* from Masisea to Cahuapana, on the Pichis, thence by canoe to Puerto Bermudez, where my former station was reoccupied, August 4 and 5. Continuing on the 5th to Puerto Yesup, where mules were obtained, Eneñas was reached on the 11th, where the desired astronomical observations were made. I finally arrived at Oroya on August 16. The weather on the return trip was, on the whole, good, as it was the last month of summer or of the dry season in the Amazon country.

The entire trip from Tarma to Masisea and return, owing to the delays stated and conditions encountered, took 86 days. Under very favorable circumstances it could have been made in 55 to 65 days. The total distance traveled from Tarma to Masisea and return, counting in the side trips, amounted to 1,270 miles, of which 530 were on mule-back and 740 by water (canoe and launch).

Local disturbances were disclosed at Baños, where there are ferruginous hot springs. The magnetic station was established 2 miles down the river from the springs, but there still seemed to be an effect, as judged by the results at the preceding stations.

The Peruvian government and officials did everything possible to further the object of the trip.

H. R. SCHMITT, ON MAGNETIC WORK IN PERU AND BOLIVIA, SEPTEMBER 1912 TO JANUARY 1913.

The instructions covering this work were those of the Director of June 27, 1912, supplemented by those of the chief of party, Mr. J. P. Ault, of August 19, 1912. The outfit consisted of magnetometer No. 14, marine chronometer No. 1044, pocket chronometer No. 244, watches Nos. 53 and 100, observing-tent, and accessories. After some practice observations at Lima, magnetic observations were made at Huacho on September 1 and active field work was commenced on September 13 at Matucana.

The 26 stations occupied were as follows:

	1912.		1912–13.
1. Huacho, Peru	Sept. 1.	14. Urcos, Peru	Nov. 6, 7.
2. Matucana, Peru	Sept. 14, 15.	15. Sicuani, Peru	Nov. 9, 10.
3. La Fundicion, Peru	Sept. 17, 18.	16. Santa Rosa, Peru	Nov. 11, 12, 13.
4. Jauja, Peru	Sept. 20, 21.	17. Tirapata, Peru	Nov. 14.
5. Huancayo, Peru	Sept. 23, 24.	18. Juliaca, Peru	Nov. 16, 17.
6. Yzcuchaca, Peru	Sept. 29.	19. Puno, Peru	Nov. 19, 20.
7. Acobamba, Peru	Oct. 3, 4.	20. Juli, Peru	Nov. 23, 24, 25.
8. Ayacucho, Peru	Oct. 10, 11, 12.	21. Guaqui, Bolivia	Dec. 3, 4.
9. Hacienda Pajonal, Peru	Oct. 15, 16	22. La Paz, Bolivia	Dec. 6, 7.
10. Andahuaylas, Peru	Oct. 19, 20	23. Santa Lucia, Peru	Dec. 12, 13.
11. Abancay, Peru	Oct. 23, 24.	24. Pampa de Arrieros, Peru	Dec. 15, 16.
12. Limatambo, Peru	Oct. 28, 29.	25. Arequipa, Peru	Dec. 21, 22, 23.
13. Cuzco, Peru	Nov. 1, 2.	26. Mollendo, Peru	Jan. 11.

Nos. 22 and 25 were reoccupations of Mr. Ault's stations.

The arrival at Cuzco on October 30 ended the traveling by mules from Huancayo, Cuzco being the terminus of the railroad from Mollendo. The trail on the whole was found a difficult one, being exceptionally rough and rocky and at a high altitude; there are many steep ascents over high mountain ranges and corresponding steep descents into the river valleys below. It is especially difficult in the rainy season, which is at its worst in February. No snow was encountered, but some hail and cold weather. The food carried along was often needed, as frequently it was impossible to secure provisions *en route*. Leaving Cuzco on November 5, the journey was continued by rail to Puno, which was reached on the 18th, 6 stations (with Puno) having been occupied on this trip. With the aid of the government launch, the use of which was obtained through the kindness of the prefect of the Department of Puno, a station at Juli, on the Peruvian shore of Lake Titicaca, was next established.

On December 2, after sending off journals and accounts and visiting the prefect of the Department of Puno, I left by the steamship *Inca* for Guaqui. La Paz was reached December 4, and Mr. Ault's station reoccupied on the 6th and 7th. The subsequent stations were as given in the list above. Special mention, however, may be made of the trip to Arequipa and the Harvard Observatory station, where the observer's work was facilitated in every way by the staff.

The whole trip from Lima to Mollendo via Huancayo, Cuzco, Puno, La Paz, and Arequipa, during which the 26 stations as listed were established, consumed 117 days, of which 99 days were actual field time, the remaining 18 days being utilized in computing, writing reports, preparing journals and accounts, arranging for trips, etc. The average field time per station was 3.8 days, somewhat high, but due to the fact that a good part of the travel was on mule-back over a hard up-and-down trail, an average of 2.5 to 3 days was required between stations only a little over a day's ride apart in an air line. Owing to the adverse weather, it took a week to establish the station Juli.

H. R. SCHMITT, ON MAGNETIC WORK IN CHILE, JANUARY TO MARCH 1913.

In accordance with the Director's instructions of June 27, 1912, the field work was started on January 25, 1913, and was closed March 20, 1913. The instrumental outfit consisted of magnetometer No. 14, marine chronometer No. 1044, pocket chronometer No. 244, and watches Nos. 53 and 100.

The following is the list of stations occupied, arranged chronologically:

	1913.		1913
1. Arica	Jan. 16, 17.	11. San Rosendo	Feb. 20.
2. Tacna	Jan. 18.	12. Concepcion	Feb. 22, 23.
3. Iquique	Jan. 21, 22, 23.	13 Coronel	Feb. 25.
4. Coquimbo	Jan. 26.	14. Victoria	Feb. 28.
5. Valparaiso	Feb. 2.	15. Temuco	Mar. 2, 5, 19.
6. Santiago	Feb. 7.	16. Loncoche	Mar. 7.
7. Rancagua	Feb. 10.	17. Corral	Mar. 9, 10.
8. Curico	Feb. 12, 13.	18. Osorno	Mar. 12.
9. Linares	Feb. 14, 15.	19. Puerto Montt	Mar. 16.
10. Chillan	Feb. 17.		

I left Mollendo, Peru, on January 14, arriving at Arica, Chile, on the 15th, observing there on the 16th and morning of the 17th. Thence the stations were occupied as shown in the above list. At Valparaiso, through the kindness of the late Dr. F. Ristenpart, the corrections of my timepieces on standard time were obtained. The total travel amounted to about 3,190 miles, of which 1,440 were by steamer and 1,750 by railroad. Per station, the average travel was 168 miles, and the average field time was 3.4 days.

W. H. SLIGH, ON MAGNETIC WORK IN ASIA MINOR, INDIA, EGYPT, AND SUDAN, JANUARY 1910 TO JUNE 1911.

In accordance with instructions of December 29, 1909, I left Washington on that day, sailing from New York on January 1, 1910, and arriving at Constantinople on January 14. The instrumental outfit used was as follows: magnetometer No. 7, dip circle No. 202, pocket chronometer No. 257, watches Nos. 70 and 71, and observing-tent No. 17. At Constantinople Observer Pearson delivered to me, for determining altitude, a boiling-point apparatus, provided with thermometers Nos. 3552 and 3556.

During the trip 84 stations were occupied, as follows:

1. Constantinople, Turkish Empire.
2. Jaffa, Turkish Empire.
3. Jerusalem, Turkish Empire.
4. Jericho, Turkish Empire.
5. Haifa, Turkish Empire.
6. Dera'a, Turkish Empire.
7. Damascus, Turkish Empire.
8. Beirut, Turkish Empire.
9. Madain-Saleh, Turkish Empire
10. Tebook, Turkish Empire.
11. Ma'an, Turkish Empire
12. Katrane, Turkish Empire.
13. Kuteifeh, Turkish Empire.
14. Nebk, Turkish Empire.
15. Karietein, Turkish Empire.
16. Palmyra (Tadmor), Turkish Empire.
17. Ain-el-Bieda, Turkish Empire
18. Homs, Turkish Empire.
19. Ummerdjim, Turkish Empire.
20. Aleppo, Turkish Empire.
21. Birejik, Turkish Empire.
22. Aintab, Turkish Empire.
23. Marash, Turkish Empire.
24. Osmanie, Turkish Empire.
25. Adana, Turkish Empire.
26. Mersina, Turkish Empire.
27. Larnaca, Island of Cyprus.
28. Alexandretta, Turkish Empire.
29. Latakia, Turkish Empire.
30. Rhodes, Turkish Empire (Island of Rhodes).
31. Smyrna, Turkish Empire.
32. Aidin, Turkish Empire.
33. Denizli, Turkish Empire.
34. Alashehr, Turkish Empire.
35. Ushak, Turkish Empire.
36. Afiumkarahissar, Turkish Empire.
37. Tchaouchdjikeuy, Turkish Empire.
38. Konia, Turkish Empire.
39. Eregli, Turkish Empire.
40. Eskishehr, Turkish Empire.
41. Adabazar, Turkish Empire.
42. Dardanelles, Turkish Empire.
43. Tcherkeskioi, Turkish Empire.
44. Adrianople, Turkish Empire.
45. Sazelar, Turkish Empire.
46. Angora, Turkish Empire.
47. Kirshehr, Turkish Empire.
48. Kaisariyeh, Turkish Empire.
49. Sivas, Turkish Empire.
50. Malatia, Turkish Empire.
51. Kharput, Turkish Empire.
52. Egin, Turkish Empire.
53. Gemakh, Turkish Empire.
54. Erzingan, Turkish Empire.
55. Mamakhatun, Turkish Empire.
56. Erzerum, Turkish Empire.
57. Madrak, Turkish Empire.
58. Kirs, Turkish Empire.
59. Bitlis, Turkish Empire.
60. Sert, Turkish Empire.
61. Jezireh-ibn-Omar, Turkish Empire.
62. Nisibin, Turkish Empire.
63. Diarbekir, Turkish Empire.
64. Mosul, Turkish Empire.
65. Kaleh Shergat, Turkish Empire.
66. Tekrit, Turkish Empire.
67. Bagdad, Turkish Empire.
68. Ramadieh, Turkish Empire.
69. Anah, Turkish Empire.
70. Hillah, Turkish Empire.
71. Amara, Turkish Empire.
72. Basra, Turkish Empire.
73. Muscat, Turkish Empire.
74. Karachi, India.
75. Alibag, India.
76. Aden, Turkish Empire.
77. Massawa, Eritrea.
78. Port Sudan, Anglo-Egyptian Sudan.
79. Suakin, Anglo-Egyptian Sudan.
80. Hodeida, Turkish Empire.
81. Jidda, Turkish Empire.
82. Tor, Egypt
83. Suez, Egypt.
84. Helwan, Egypt.

Intercomparisons of instruments were made in the field with Mr. Pearson at Robert College, Constantinople, under great difficulties because of high wind, rain, and cold, and at the magnetic observatories located at Alibag (near Bombay), India, and at Helwan, Egypt. Mr. Pearson's stations at Basra (No. 72), Aden (No. 76), and Suez (No. 83) were reoccupied.

On February 3, I, with my interpreter, sailed from Constantinople, arriving at Jaffa Syria, February 8, where observations were made February 9 and 10. On February 11 we went by rail to Jerusalem, securing observations on February 12. A station at Jericho appeared desirable on account of the peculiar geographical conditions, and a trip was made there from Jerusalem. We arrived in Damascus February 25, going via Jaffa, Haifa, and Dera'a and observing *en route* at Haifa and Dera'a. With the assistance of the American consul general at Beirut, Mr. G. B. Ravndal, who happened to be at Damascus, permission was obtained from the Vali to go as far south as Madain-Saleh. Christians are not allowed to go beyond this point.

The Damascus-Medina railroad service being interrupted by a storm, opportunity was taken to observe at Beirut on March 6. While setting up the theodolite here for latitude observations, a violent gust of wind threw the tent down, but, fortunately, no damage resulted to the instrument. Leaving Damascus March 14 for the Hedjaz, we arrived in Madain-Saleh March 16. On the return, observations were made at Tebook, where we were put in quarantine for 5 days, but, by courtesy of the Turkish officers, we were allowed to proceed with our work. Observations were next secured at Ma'an and at Katrane; letters of introduction from one of the railway-supply contractors greatly facilitated this work.

Upon return to Damascus on April 2, arrangements were undertaken for a trip to Palmyra. This was made by carriage, an escort of two gendarmes, as advised by the Turkish authorities, accompanying the party. The traveling was done in the early part of the day, the afternoons being utilized for the observational work. Stations were established at Kuteifeh, Nebk, Karietein, Ain-el-Bieda, and Palmyra. From Palmyra we returned to Homs, on the Damascus-Aleppo railroad, to the north of Damascus, and secured observations at Homs and Ummerdjim, arriving at Aleppo April 21. We left the latter place on April 30, and went by carriage to Birejik on the Euphrates, returning to Aintab May 4.

On May 7 we set out with pack animals for Marash, arriving there May 8, and secured observations on May 11 and 12. Making observations *en route* at Osmanie, Adana was reached May 18. Between Marash and Adana troublesome rains were encountered. From Adana we went by rail to Mersina, May 20, then by steamship to Larnaca and thence to Latakia on the Syrian Coast. *En route* observations were made at Alexandretta.

It was necessary to return to Beirut to take the steamer for Rhodes, where we arrived June 12, and continued thence to Smyrna and then by rail to Aidin and Denizli, returning to Smyrna on June 25. Between June 27 and July 6 observations were made along the railroad eastward at Alashehr, Ushak, Afiumkarahissar, Tchaouchdjikeuy, Konia, and Eregli. While returning from Eregli to Constantinople (July 13) observations were secured at Eskishehr and Adabazar. From Constantinople trips were made to the Dardanelles and to Adrianople. Shortly after returning, during the last of July, the observer was forced to go to the hospital for one week on account of malarial fever.

On August 15, the party, consisting of the observer, the interpreter, and a cook, set out from Constantinople for Bagdad. We went by rail to Angora, making observations at Sazelar *en route*, thence by carriage to Kharput, observing *en route* at Kirshehr, Kaisariyeh, Sivas, and Malatia. From Kharput we crossed, by pack animals, the Dersim to Erzingan, a very picturesque and wild, rough, mountainous country. *En route* observations were made at Egin and Gemakh. We arrived at Erzingan September 27 and continued our journey by caravan to Erzerum, which was reached October 4. We were now in the Taurus Mountains, and during the day suffered from cold winds; at night, the temperature fell below zero. On the borders of the vilayet, near Mush, we were again quarantined for 3 days. Bitlis was reached on October 21, and thence we descended into the Tigris Valley by the Bitlis Pass to Jezireh-ibn-Omar. Observations were made October 31 at Sert, on the Tigris. From Jezireh we proceeded across the desert to Nisibin and, via Mardin, to Diarbekir on the Tigris, arriving there November 11. From Kharput to Diarbekir the journey, occupying about 56 days, was made by pack animals, a distance of approximately 800 miles.

At Diarbekir two rafts (keleks) were constructed, one for the observer and interpreter and the other for the cook and for his kitchen. A number of goatskins were filled with air, on which platforms were laid for the erection of huts and tents. The kelekjes, by means of long poles with paddles nailed to the ends, guided the keleks, floating with the current. We began our journey down the Tigris on November 17, the mountains around Diarbekir

being covered with snow. In the upper part of its course the Tigris passes through some grand scenery—deep gorges and mountains, from which flow many beautiful, clear streams. Mosul was reached December 2, and Kaleh Shergat, December 9. At Kaleh Shergat a German expedition was excavating the ancient Assyrian city of Asshur. At the request of the director of the expedition, azimuth determinations were made on the site of the excavations. Magnetic elements were also determined at Kaleh Shergat. We arrived at Bagdad December 17. The winter at Bagdad was unusually severe.

Supplied with letters to the authorities in the Euphrates and Tigris Valleys, from Nazim Pasha, then vali of Bagdad, and afterwards commander of the Turkish army in eastern Macedonia, we set out December 28 by carriage from Bagdad to go to Anah on the Euphrates. On December 30 at Ramadieh we were put in quarantine on account of cholera at Bagdad; however, while in quarantine, the desired observations were made. We arrived at Anah January 7, 1911, made observations January 8, and set out on the return journey January 9, Bagdad being again reached January 16. A second trip from Bagdad was made by carriage to Hillah, which was reached January 25. The day we set out on the return journey was the coldest experienced by me in the 3 years of travel. We returned to Bagdad January 30. About February 1, at Bagdad, the observer dispensed with his interpreter and employed instead an Arab, who acted both as interpreter and as cook.

On February 7 we went by steamer to Basra, arriving there February 12, securing *en route* observations at Amara, and sailing next to Muscat, which was reached February 22. At Muscat we tried to arrange for a trip along the coast of Arabia from Muscat to Aden, but though most cordially assisted by the British representative, we were obliged to abandon the attempt. Instead we sailed to Bombay. With the cooperation of the director of the observatories at Bombay, Mr. N. A. F. Moos, intercomparisons of instruments were secured at the Alibag Observatory.

We arrived at Aden March 31 and reoccupied one of Mr. Pearson's stations. Leaving Aden April 3, we landed at Massawa April 5, where observations were made, as also at Port Sudan, Suakin, Hodeida, and Tor. Mr. Pearson's station at Suez was reoccupied. At Suakin passage was taken on the steamship *Mansourah,* commanded by Captain Spagna, through whose influence observations were made possible at Jidda and Tor.

At Helwan, through the courteous cooperation of the observatory authorities, intercomparisons of instruments were made, the work being completed here June 1, 1911.

The observer wishes to make particular note of the kind treatment received from the Turkish officials and from the people. In the far interior it was often necessary to utilize private fields and gardens for observing; at no place, after the object was explained, was there objection made. Many courtesies were extended by various persons, consuls, missionaries, and government officials.

The time required for the work from the date of leaving Washington, December 29, 1909, to the completion of the work at Cairo (Helwan), June 1, was 17 months, or 518 days. This was about 6 days per station occupied, including intercomparisons of instruments at Constantinople, Alibag, and Helwan. About 22,300 miles were traversed; of this about 5,400 miles were covered in reaching the field. Of the total distance, 12,340 miles was by steamship on sea, 6,900 miles by railroad, 1,500 miles by carriage, 940 miles by pack animals through the mountains, and 600 miles by raft (keleks) on the Tigris River. Excluding the travel in reaching the field, the average number of miles traversed in reaching each station was about 200.

W. H. SLIGH, ON MAGNETIC WORK IN THE BALKAN STATES, TURKEY, AND ITALY, JUNE TO NOVEMBER 1911.

In accordance with instructions dated October 28, 1910, and March 31, 1911, I set out from Cairo, Egypt, on June 7, 1911, with the following instrumental outfit: magnetometer No. 7; dip circle No. 202; observing-tent No. 17; pocket chronometers Nos. 244 and 257; watch No. 70; boiling-point apparatus, for determining altitudes, with thermometers Nos. 3552 and 3556.

During this expedition 21 stations were occupied, as follows:

1. Rumeli Hissar (Constantinople), Turkey.
2. Burghas, Bulgaria.
3. Nova-Zagora, Bulgaria.
4. Philippopolis, Bulgaria.
5. Sofia, Bulgaria.
6. Nissa, Serbia.
7. Uskub, Turkey.
8. Mitrovitsa, Turkey.
9. Salonica, Turkey.
10. Monastir, Turkey.
11. Drama, Turkey.
12. Dede-Agach, Turkey.
13. Athens, Greece.
14. Kephisia, Greece.
15. Candia, Island of Crete.
16. Zante, Greece (Island of Zante).
17. Patras, Greece.
18. Corfu, Greece (Island of Corfu)
19. Terracina, Italy.
20. Rome, Italy.
21. Valetta, Island of Malta.

At Constantinople, owing to the erection of a building, the sites of the earlier stations of the Department could not be reoccupied. A new site was, therefore, selected about a half mile away; at Athens, intercomparisons of instruments were made at the magnetic observatory there and the observatory station at Kephisia was reoccupied; at Terracina, Italy, intercomparisons were secured with the magnetic standards of Italy. At Constantinople letters of recommendation were obtained from the Bulgarian, Serbian, and Grecian legations. Letters were also obtained for the various vilayets in European Turkey. Mr. George C. Turner, an Englishman, was employed as interpreter for the expedition.

We set out by rail from Constantinople, June 29, going to Burghas, Bulgaria, via Adrianople and Philippopolis. Magnetic observations were made at Burghas and at the 4 following stations. Then we went to Uskub, where we were most kindly received by the vali, who gave us letters to the authorities at Mitrovitsa, our next station, which was followed by Salonica and Monastir. Leaving Salonica July 27, and making observations at Drama and Dede-Agach, we returned to Constantinople July 30, having been gone 31 days, during which 11 stations were occupied and about 2,550 miles covered by rail.

We sailed from Constantinople for Athens August 1, being quarantined 5 days at Salamis. After the completion of the intercomparisons at the Athens Observatory and the observations at Kephisia, we sailed from Piræus September 1, going to Candia and from there to Zante, via Piræus. At Patras the interpreter returned to Constantinople and I proceeded to Rome, where, through the courtesy of Professor Palazzo, the director of the Meteorological and Magnetic Service of Italy, my instruments were cleaned and repaired at the observatory. Though Professor Palazzo was very busy at the time, he went with me to Terracina and took part in the intercomparisons of our respective instruments. I also made magnetic observations at Rome; having completed this work, I was obliged to take a rest here of about 17 days. Leaving Rome November 1, for Malta, I was quarantined there for 5 days. Observations were made at Valetta, Malta, November 11 and 14, my last station on this trip. About 6,300 miles were traversed, 2,500 by steamship and 3,800 by railroad.

W. H. SLIGH, ON MAGNETIC WORK IN NORTHWESTERN AFRICA, TUNIS TO SIERRA LEONE, NOVEMBER 1911 TO DECEMBER 1912.

In accordance with instructions of March 13, 1911, I set out from Valetta, Malta, November 16, 1911, with the following scientific outfit: magnetometer No. 7; dip circle No. 202; observing-tent No. 17; pocket chronometers Nos. 226 and 244; watch No. 102; and boiling-point apparatus provided with thermometers Nos. 3552 and 3556, for altitude determinations. Observer D. W. Berky joined the party at Gibraltar on March 28, 1912.

During the expedition 61 stations were occupied, 46 by myself and 15 by Observer Berky.

TABLE 10.

No.	Name	Country	Date	Observer
1	Valetta	Island of Malta	1911 Nov. 11, 14	WHS
2	Palermo	Italy (Island of Sicily)	Nov. 19	WHS
3	Tunis	Tunisia	Nov. 27	WHS
4	Susa	Tunisia	Dec. 3.	WHS
5	Sfax	Tunisia	Dec 5, 9, 11	WHS
6	Houmt-Souk	Tunisia (Jerba Island)	Dec. 7, 8	WHS
7	Metlaoui	Tunisia	Dec 12	WHS
8	Feriana	Tunisia	Dec 13, 14	WHS
9	Souk-Ahras	Algeria	Dec 17	WHS
10	El-Guerrah	Algeria	Dec 19	WHS
11	Biskra	Algeria	Dec. 21	WHS
12	Philippeville	Algeria	Dec. 24, 25	WHS
13	Setif	Algeria	Dec. 27	WHS
14	Bougie	Algeria	Dec 28, 29	WHS
15	Algiers	Algeria	1912 Jan. 3–7, 9, 11–13, Nov. 30, Dec 3–7, 9, 10	WHS
16	Orleansville	Algeria	Jan. 28, 29	WHS
17	Tiaret	Algeria	Feb. 5	WHS
18	Bedeau	Algeria	Feb. 7, 8	WHS
19	Saida	Algeria	Feb. 11	WHS
20	Le Kreider	Algeria	Feb. 13, 14	WHS
21	Ain Sefra	Algeria	Feb. 15, 16	WHS
22	Colomb-Bechar	Algeria	Feb. 18, 19	WHS
23	Beni-Ounif	Algeria	Feb. 21	WHS
24	Oran (Gambetta)	Algeria	Feb. 27, 28	WHS
25	Oran	Algeria	Mar. 1	WHS
26	Nemours	Algeria	Mar. 9, 10	WHS
27	Melilla	Morocco	Mar. 13	WHS
28	San Roque	Spain	Mar 25, Apr. 11–13, 15, 16.	WHS & DWB
29	Tangier, *A*	Morocco	Apr. 5	WHS
30	Tangier, *B*	Morocco	Apr. 5, 6, 7	WHS & DWB
31	Laraish, *A*	Morocco	1912 May 3.	WHS
32	Laraish, *B*	Morocco	May 3	DWB
33	Las Palmas	Canary Ids	May 18	WHS
34	Santa Cruz	Canary Ids	May 20	WHS
35	Morro Jable Point	Canary Ids	June 10	WHS
36	Cape Juby	Morocco	June 13	WHS
37	Arecife	Canary Ids.	June 26	WHS
38	Cape Nachtigal.	Morocco	July 2	WHS
39	Cape Bojador	Morocco	July 5, 6	WHS
40	Villa Cisneros	Rio de Oro.	July 9	WHS
41	Cape Corveiro	Rio de Oro	July 12, 13	WHS
42	Cape Blanco	French West Africa	July 15, 16	WHS
43	Portendick	French West Africa	July 19, 20	WHS
44	St Louis	French West Africa	July 26	WHS
45	Dakar	French West Africa	July 30, 31, Aug. 15.	WHS
46	Kaolack	French West Africa	Aug 2, 3	WHS
47	Koumpentoum	French West Africa	Aug. 7	WHS
48	Rabat	Morocco	May 7, 8	DWB
49	Casablanca	Morocco	May 13, 14	DWB
50	Mazagan	Morocco	May 15, 16	DWB
51	Saffi	Morocco	May 17, 18	DWB
52	Mogador	Morocco	May 23, 24	DWB
53	Bathurst, *A*	Gambia	June 11, 12	DWB
54	Bathurst, *B*	Gambia	June 18	DWB
55	Freetown	Sierra Leone	June 25.	DWB
56	Moyamba	Sierra Leone	July 1, 2, 3	DWB
57	Bo	Sierra Leone	July 6, 7	DWB
58	Baiima	Sierra Leone	July 9, 10	DWB
59	Conakry	French Guinea	July 23–26, Aug 17	DWB
60	Kindia	French Guinea	July 30, 31, Aug 1.	DWB
61	Mamou	French Guinea	Aug 6, 7, 13, 14	DWB

In addition to the above, intercomparisons of instruments were secured by me at the Algiers Observatory in January, November, and December, 1912, and I also reoccupied Observer Johnston's station at Las Palmas. Observers Berky, Sawyer, and myself made special eclipse observations at Algiers, October 10, 1912.

Leaving Valetta November 16, 1911, with an interpreter, we arrived at Tunis November 22, going via Syracuse, Messina, and Palermo. *En route* magnetic observations were made at Palermo. From Tunis we went to Susa and Sfax and thence by sea to Jerba Island, returning to Sfax and then going by rail to Metlaoui and Feriana. From Feriana we had intended going across country to Tebessa, about 2-days' journey, but the Arab chief at Feriana would not permit men, animals, or carts to go with us. So we went to Souk-Ahras via Tunis. Observations were also made at El-Guerrah, Biskra, Philippeville, Setif, Bougie, and Algiers, which place was reached December 30. At Algiers, by request of the director of the Algiers Observatory, intercomparisons of instruments were made January 4 to 12, 1912. We were much delayed by bad weather—rain and wind; the observing-tent was ripped to pieces by violent winds and a new one was made at Algiers.

We finally left Algiers January 26, 1912. *En route* from Orleansville to Tiaret, the observing-tent went astray, causing a week's loss, but it was finally recovered through the prompt assistance of the American consular agent, Mr. Elford. From Tiaret the journey was continued to Bedeau, Saida, Le Kreider, Ain Sefra, Colomb-Bechar, and then back to Beni-Ounif and to Oran. It was not found feasible to make observations in the vicinity of the previous station established by M. Moureaux at Oran, the site being near a masked battery. A new station in a more favorable place was therefore selected.

From Oran I went by sea to Nemours and then to Melilla, at which place a detachment of 4 gendarmes and 5 or 6 soldiers kept guard while I was making the desired magnetic observations. Thence I proceeded by sea to Tangier, where instructions dated March 13, 1912, relating to program of further work in Africa, were received. In accordance with these instructions, Observer D. W. Berky arrived at Gibraltar March 28 and was instructed in methods of field work at Gibraltar and Tangier. We left Tangier together on May 1, going to Laraish, and making observations here on May 3. At Rabat Mr. Berky went ashore with the interpreter and made observations alone. At Casablanca we separated, I going to Santa Cruz de Teneriffe, Canary Islands, and reoccupying *en route* Observer Johnston's station at Las Palmas. Mr. Berky made observations at Mazagan, Saffi, and Mogador, and arrived at Las Palmas about June 1; 3 days later he set out for Bathurst to continue the work along the west coast of Africa.

At Santa Cruz de Teneriffe I chartered the *Ena*, a fishing sloop of 44 tons, manned by 7 sailors and a captain. Accompanied by an interpreter, we sailed on June 9. Because of very high wind, it was necessary to anchor on the morning of June 10 under Morro Jable Point, Fuerteventura Island. The opportunity was taken to make observations here. A few minutes before completing work, tent, dip circle, and observer were hurled to the ground by a violent gust of wind, but fortunately no serious damage resulted. We landed at Cape Juby June 12 and were cordially received by the natives. By the advice of the owner of the sloop, 2 Moors were taken on here, who proved of great value and service during the voyage. Arriving at Agadir Bay June 22, and finding that we were not allowed to land, sail was set for Arecife, Lanzarote Island, which place, after taking on water and provisions, we left June 28, intending to go to Wady Dra'a, but instead struck the coast, about 17 miles to the southward, at Cape Nachtigal. Here the native fishermen warned us that a large party of Bedawi were near; the Moors were accordingly posted as sentinels during the observations, which, in view of the warnings, it was deemed wise to abbreviate as much as possible. A landing was made at Cape Bojador, July 5, during a violent wind; it required about $2\frac{1}{2}$ hours to set up the tent, and, on account of the dust and sand that filled the air, it was necessary to return again the next day to complete the work. The captain tried to prevail on us not to return ashore, being fearful of the natives, whom the fishermen from Arecife had advised of our coming, but we were not molested.

We arrived at Villa Cisneros, a fishing station and trading post protected by a fort garrisoned by Spanish soldiers, July 7, and on July 8 called on the Governor of Rio de Oro, who received and entertained us most cordially. Observations were made July 9, despite a violent wind and the difficulties on account of dust and sand. There is no fresh water or vegetation at Villa Cisneros, all supplies, including water, being brought from the Canary Islands. The captain of the sloop tried to prevail on the governor to prevent us from making further landings on the coast. The governor informed us that it was very dangerous, but said that he knew we were working in the cause of science and were willing to take risks.

Observations were made at Cape Corveiro July 12 and 13. Arriving at Cape Blanco, we called on the commandant July 14 and were given permission to make observations. Due to poor management of the sailors, we were upset in landing and the instruments were under water. While ashore we were given shelter in the lighthouse by the keeper. The observations were much disturbed by wind, sand, and dust. Leaving Cape Blanco July 17,

we anchored in the neighborhood of the former trading post of Portendick—long since abandoned. Between this point and Cape Blanco no landings were possible, as the coast is very dangerous, and even here we had to lie 8 or 10 miles to sea on account of reefs. The observations here were made at Portendick on July 19 and 20, the 2 Moors being posted as sentinels. Some excitement was occasioned here by their mistaking several negro fishermen, the slaves of nearby Arabs, for a troop of Bedawi. We arrived finally at St. Louis, July 23, after a voyage of 44 days, in which over 2,000 miles had been covered (the sloop had been chartered for 45 days). The forethought and wise arrangements of the owner of the sloop, Mr. Sampson, aided much in the success of the voyage. In particular, very good service was given by the 2 Moors, by the interpreter, who showed great courage and patience, and by a member of the crew, who assisted in the usually very difficult landings and looked after the observer while he was sick aboard.

At St. Louis we were very kindly and cordially received and given every assistance, both by the officials and citizens. Observations were made at St. Louis, Dakar, Kaolack, and Koumpentoum, and on August 16 we sailed by steamship from Dakar for Algiers, going via Las Palmas, Cadiz, and Gibraltar, and arriving at Algiers, September 2.

Mr. Berky left Las Palmas June 4, 1912, going to Bathurst. From Bathurst he went to Freetown and followed the railroad to its terminus at Baiima. Returning to Freetown, he went thence to Conakry and observed at 8 stations along the railroad into the interior. Having satisfactorily accomplished all that was possible under conditions most trying at times, he proceeded to Algiers, where he arrived September 2.

At Algiers we immediately took up the problems of the trans-Saharan expedition, in which every possible assistance was received from the French Government. Commandant Meynier, chef de cabinet of the governor-general of Algiers, who has seen many years of service in the Sahara, advised us as to equipment, travel, etc., and arranged for the organization of caravan at Biskra. Observer H. E. Sawyer arrived on September 29. On October 29 the trans-Saharan expedition was ready to set out from Biskra, in charge of Mr. Berky, assisted by Mr. Sawyer. Having concluded all matters with regard to this expedition, I thereupon, at the request of the director of the Algiers Observatory, again intercompared our respective magnetic standards, this work being completed December 10. Director Gonnessiat and the members of his staff had done everything possible to further the work of the expedition. On December 15, I sailed from Algiers, and reported at Washington, January 6, 1913.

The total mileage traversed by me during the work was about 13,600; approximately 7,200 by steamship, 4,400 by railroad, and 2,000 in a 44-ton sloop. About 5,600 miles were traversed in returning to Washington from the field of work, so that about 8,000 miles were traveled in the field, giving an average of about 186 miles per station. The total mileage covered by Observer Berky from Washington to field of work at Gibraltar and from Conakry to Algiers via Boulogne and Marseille was about 10,200—8,900 by steamship and 1,300 by railroad. About 3,300 miles were traversed in coming to field of work at Gibraltar and about 4,100 miles in returning to Algiers from Conakry, so that only about 2,800 miles were required for the actual field travel, or, on an average, about 215 miles per station.

C. C. STEWART, ON MAGNETIC WORK IN BRAZIL, PERU AND BOLIVIA, JUNE 1910 TO JULY 1911.

Acting in accordance with the instructions issued to me on April 14, 1910, and after about 2 months spent in preparation for the work to be undertaken, I sailed from New York on June 15, 1910, for the port of Manaos, near the mouth of the Rio Negro, in Brazil,with the following instrumental outfit: magnetometer No. 13; dip circle No. 177, with dip needles Nos. 1, 2, 5, 6, and intensity pair Nos. 3 and 4; box chronometer No. 270; pocket chronometer No.251,and Hamilton watch No.51; pocket compass No.2, and miscellaneous accessories. A specially constructed launch, called *El Imán* was shipped to me at

Manaos by the next steamer from New York. Mr. W. C. Hamer, an engineer, was taken with me from the United States, all other helpers being obtained in the field.

During the 6 weeks following the arrival of the expedition in Manaos on July 8, the time was spent in the requisite preparations, securing the necessary credentials and supplies, and in occupying 2 stations in distant parts of the city of Manaos. On August 20, 1910, we were ready to leave Manaos, in the launch, for Iquitos, Peru, which port was reached in the latter part of September, after making observations at 19 stations *en route*. Owing to the poor operation of the engine and the breaking of some necessary parts, the launch had to be left at Iquitos while awaiting the arrival of the new parts from New York. During this delay, by means of local boats, I made a trip up the Ucayali River, and another to Yurimaguas on the Huallaga River, securing a goodly number of observations.

The new engine parts arrived from New York about the end of the year and we immediately prepared to continue the work with the launch. However, a few days before the start was planned to be made the launch unfortunately was destroyed by fire. After disposing of the remaining supplies and of the hull, I continued the work as was possible with the local conveniences of transportation. A canoe trip was made to the Alto Maranon during the month of February 1911, this completing the work in Eastern Peru, as outlined in my instructions, with the exception of the trip along the Ica or Putomayo River, which, for lack of the requisite transportation facilities, had to be given up.

Magnetic observations were next made at various points between Manaos and the mouth of the Amazon River, and by May a line of stations had been established almost completely across the equatorial part of South America. After a short illness I made, during May to July, a trip up the Madeira River and occupied various stations along the line of the Madeira and Mamoré Railroad, which was then under construction. Thereupon, being taken seriously ill, I was compelled to leave the country. Returning to Manaos, I took passage for Pará, intending to change to a south-bound steamer at that port and to continue the work in a more healthful part of South America, but, when Pará was reached, I was too sick to leave the steamer and had to be taken on to Liverpool, where I was placed in a private hospital for about 24 days. I was finally able to sail for the United States on September 16 and reported at Washington as soon thereafter as possible.

The following stations were occupied in the order named:

1. Manaos, Brazil, station II.
2. Amazon 1, Brazil.
3. Amazon 2, Brazil.
4. Amazon 3, Brazil.
5. Amazon 4, Brazil.
6. Amazon 5, Brazil
7. Amazon 6, Brazil
8. Amazon 7, Brazil
9. Amazon 8, Brazil.
10. Amazon 9, Brazil.
11. Amazon 10, Brazil.
12. Amazon 11, Brazil.
13. Amazon 12, Brazil.
14. Amazon 13, Brazil
15. Amazon 14, Brazil.
16. Amazon 15, Brazil
17. Amazon 16, Brazil.
18. Amazon 17, Peru
19. Amazon 18, Peru.
20. Amazon 19, Peru.
21. San Jorge, Peru.
22. Nauta, Peru.
23. Avispa, Peru.
24. Filadelfia, Peru.
25. Condor Conqui, Peru.
26. Delicia, Peru
27. Petronela, Peru.
28. Cantumayo, Peru.
29. Masisea, Peru
30. Sheshea, Peru
31. Sempaya, Peru.
32. Iquitos, Peru.
33. Yurimaguas, Peru (2 stations).
34. Tres Unidos, Peru
35. Libertad, Peru.
36. Barranca, Peru.
37. Itacoatiara, Brazil.
38. Obidos, Brazil.
39. Santarem, Brazil.
40. Monte Alegre, Brazil.
41. Urucurituba, Brazil.
42. Gurupa, Brazil
43. Antonio Lemos, Brazil.
44. Pinheiro, A, Brazil.
45. Parintins, Brazil
46. Porto Velho, Brazil.
47. Caracol, Brazil
48. Mutum, Brazil
49. Abuná, Brazil.
50. Camp 39, Brazil.
51. Guayara Mirim, Bolivia.

At Nos. 1, 39 and 44, magnetic observations had been made previously; however, only No. 44 could be reoccupied exactly.

The American consuls at Para and Manaos, especially Mr. Fred Sanford, the acting American consular agent at Manaos, rendered valuable assistance to the expedition. The British consul in Iquitos, Peru, kindly arranged the running of his trading steamer on the Ucayali River so that observations could be more easily made in that region. Messrs. May and Jekyl, the contractors building the Madeira and Mamoré Railroad, facilitated, in every way possible, the work in the region of their operations. Both the Brazilian and the Peruvian officials rendered whatever aid lay within their power and extended various courtesies.

E. N. WEBB, ON THE MAGNETIC-SURVEY RESULTS OBTAINED BY THE AUSTRALASIAN ANTARCTIC EXPEDITION, 1911–1913.[1]

The instrumental outfit for the expedition included: a magnetograph, two 3-inch theodolites by Negretti and Zambra provided with 4-inch trough needles, two 3-inch Cary theodolites, chronometers, thermometers, hypsometer, aneroid, sledge-meter, and other appurtenances. A Barrow dip circle was supplied by the Christchurch Observatory, and magnetometers Nos. 6 and 9, dip circles Nos. 169 and 178, and pocket chronometers Nos. 252 and 253 were supplied by the Department of Terrestrial Magnetism.

Before leaving Hobart, in December 1911, the two sets of magnetic instruments were carefully compared with the Department standards. (See Mr. Kidson's report, p. 109.) At Macquarie Island, 2 primary stations were occupied, one at Caroline Cove, and the other at the north end, where also 3 secondary declination stations were occupied. A landing was next made at Commonwealth Bay, Adelie Land; here winter quarters were established, and a magnetograph house and an absolute hut were constructed for the magnetic work. During the 11 months at Commonwealth Bay, the magnetograph was in continuous operation, except for about 15 days; absolute magnetic observations were made regularly under very severe and trying circumstances.[2]

In an attempt to secure a magnetic station free from local disturbance, an ice cave was excavated 250 feet above rock and one-half mile away from the rock outcrop. Two complete sets of observations were secured here in the winter.

During the autumn several attempts were made to carry out sledge journeys, but, owing to the exceedingly violent winds, nothing was attained until finally in November three parties were successfully started. Dr. Mawson with Lieut. Ninnis and Dr. Mertz went east with two dog teams, carrying a light 3-inch Negretti and Zambra theodolite with a trough needle. Messrs. Madigan and Correll and Dr. McLean went east also, carrying a 3-inch Cary theodolite and the Christchurch dip circle. A third party, consisting of Messrs. Bage, Webb, and Hurley, went south.

Mr. Madigan, on the eastern journey, observed both dip and declination at 6 stations, declination only at 5 stations, and dip only at 2 stations, fairly evenly distributed over 270 miles. Several of these stations were on sea ice.

The southern sledge journey, equipped with dip circle No. 178, Cary 3-inch theodolite, hypsometer, etc., covered in all about 301 miles out by sledge-meter. Complete magnetic observations were made at 7 stations evenly distributed, while rough determinations of declination (with declinometer and sun compass) were obtained at several camps. The dip observed at the extreme station was 89° 43′.3 south. On the return journey the party was hampered a great deal by continued overcast weather and falling snow, and was therefore unable to locate a depot 70 miles from base. With provisions almost exhausted, it then became necessary to leave behind all outfit not absolutely necessary, and to make a dash for the coast, arriving at headquarters considerably exhausted. Included in the outfit thus abandoned was dip circle No. 178. The determinations of the total-intensity constant and of the dip-needle corrections are therefore based entirely on intercomparison observations made before this journey, namely, at Hobart and Commonwealth Bay.

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[1]A fuller report will be published by the Australasian Antarctic Expedition.

[2]The magnetic-observatory work will be discussed and published by the Australasian Antarctic Expedition.

SYNOPSES OF ADDITIONAL MAGNETIC SURVEYS, 1911–1913.

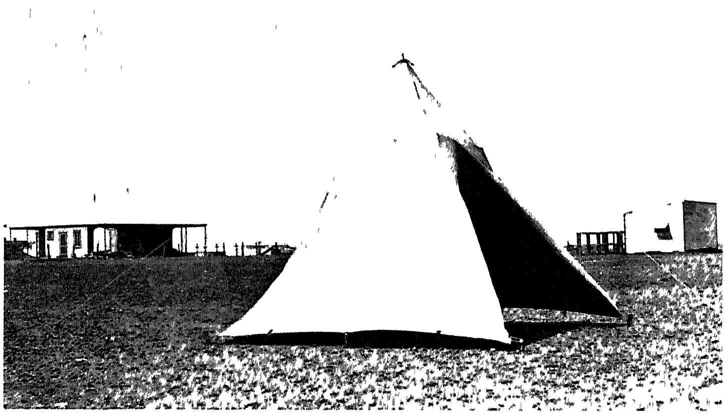
Besides the surveys and trips briefly described in the foregoing field reports, the following work was undertaken during the period 1911–1913.

H. E. Sawyer.—In pursuance of instructions of September 16, 1912, and August 8, 1913, Mr. Sawyer, after the division of Mr. Berky's party, left Timbuktu July 21, 1913, to undertake work along the coast of West Africa. He followed the courses of the Niger and Senegal rivers to the coast, arriving at St. Louis, Senegal, October 20, 1913. From this point he traveled by means of coast steamers along the west coast of Africa towards Lagos, from which point a general magnetic survey of Nigeria was started by him in 1914. By the end of 1913 he had worked his way, observing at 19 points where steamers land, as far south as Grand Bassam, Gold Coast. The results obtained by him will be found in the "Table of Results." At some of the stations occupied, magnetic observations had been made previously; thus secular-change data were also obtained.

W. F. Wallis.—On October 17, 1913, Mr. Wallis left Washington to secure a series of magnetic observations in northern Africa. He first proceeded to Rome, where he arrived November 1. Here he reoccupied Mr. Sligh's station of 1911. From Rome he went to Terracina in company with Professor L. Palazzo, with whose courteous assistance an intercomparison with the magnetic standards of the Ufficio Centrale di Meteorologia e Geodinamica was secured. Thence he traveled to Tripoli, obtaining observations at Messina and Palermo *en route*, and arriving December 15. At the end of 1913, 2 stations in Tripolitania had been secured, one of which was a reoccupation of Professor Palazzo's station of 1905. Most cordial assistance was rendered Mr. Wallis at all places visited. Especial acknowledgment, however, is due the Italian Minister of Colonies, Signor Bertolini, and the Honorable Thomas Nelson Page, American ambassador to Italy, for securing the requisite credentials. Professor L. Palazzo did everything in his power to further the work, and the Honorable J. Q. Wood, at that time American consul for Tripolitania, contributed greatly to the success of the expedition in Tripolitania.

1

2



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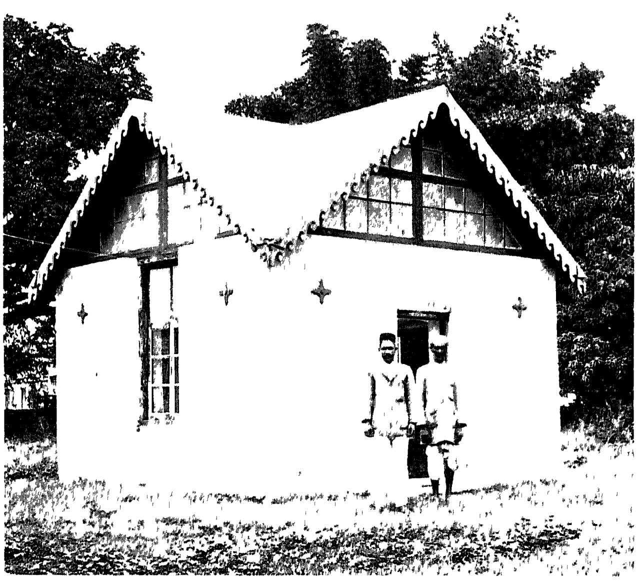

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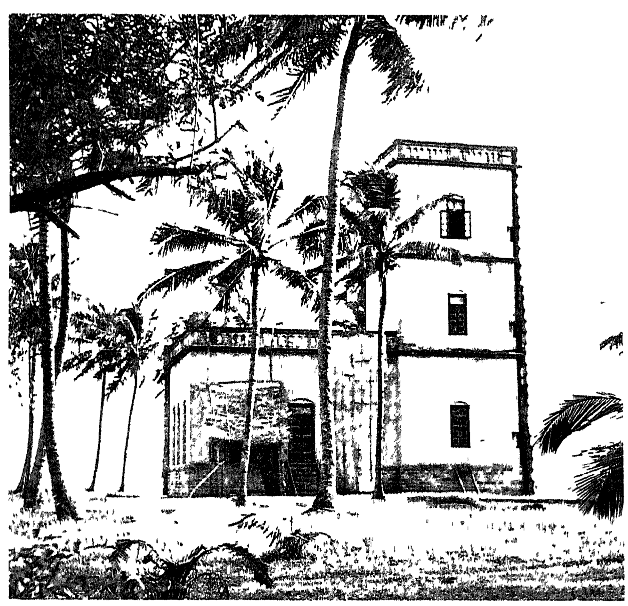

6

Typical Views of Magnetic Expeditions in Asia and Australia.

1 Lao-Kay, Tonkin, Indo-China.
2. Pitsanuloke, Siam.
3 Oodnadatta, South Australia.
4. Oatlands, Tasmania
5 Dehra Dun, base station of magnetic survey of India.
6. Alibag Magnetic Observatory, India, house for absolute observations.

DESCRIPTIONS OF STATIONS.

As stated in the previous volume, one of the chief difficulties experienced by the observers of the Department of Terrestrial Magnetism in the reoccupation of old stations for secular-variation data has been the lack of necessary information to permit precise recovery of the point where the previous observations were made. Owing to the frequent occurrence of local disturbances, it may readily happen that erroneous secular-variation data will result from non-recovery of exact station. Accordingly the observers of the Department are instructed to furnish as complete descriptions as possible of stations occupied, especially of such as give promise of future availability. Information additional to that contained in the published descriptions or copies of station-sketches or of photographs of surroundings will gladly be furnished those who are interested in the reoccupation of any of the stations.

The descriptions are given in alphabetical order under the same geographical divisions adopted in the Table of Results. The general form followed in the descriptions is: Name of station, year when occupied, general location, detailed location, distances and references to surrounding objects, manner of marking, and finally the true bearings of prominent objects likely to be of permanent character. All bearings, unless specifically stated otherwise, are true ones, and are reckoned continuously from 0° to 360°, in the direction, south, west, north, east. Occasionally no description of a station listed in the Table of Results will be found; this is because the description as furnished by the observer, for one reason or another, was too meager to be worth publishing. For some expeditions, owing to the absence of surrounding objects to which reference could be made, the descriptions of stations naturally could not be made very full or precise. When no mention is made of marking of station, it is to be understood that the station was either not marked at all or not in a permanent manner.

The majority of the measured distances were made originally in the English system; however, the distances obtained by conversion into the metric system are also given, but inclosed in parentheses, so as to show that they are converted figures. The following rules have been adopted in the conversions: distances given to 0.01 foot are converted to the nearest 0.001 meter, 0.1 foot to the nearest 0.01 meter, 1 foot to the nearest 0.1 meter, estimated feet or yards to nearest meter, estimated fraction of a mile to nearest 0.1 kilometer, estimations of more than a mile to nearest kilometer. Short and important reference distances, when measured accurately, have been converted into nearest 0.1 centimeter; such measurements, however, as, for example, dimensions of marking-stones, etc., which are not of great importance, have been converted to the nearest centimeter. If a distance is given immediately preceding an azimuth of a mark, it is to be interpreted as distance from the magnetic station to the mark.

AFRICA.

ALGERIA.

Ain Sefra, Ain Sefra, 1912.—About 1 kilometer west of town, near Arab cemetery, about 200 meters east of Marabout of Sidi Boujema, 200 meters north of Oued Ain Sefra, 27.5 meters west of northwest corner of Arab cemetery, and 30 meters northwest of southwest corner; marked by wooden peg driven flush with ground. True bearings: dome of Marabout of Sidi Boujema, 56° 48′.8, cross on church in Ain Sefra, 242° 59′.8; lone dome on building in military quarters, 267° 01′.8

Algiers, Algiers, 1912.—Intercomparison observations at the Bouzareah Observatoire d'Alger were made at the Moureaux station, designated *M*, and on pier designated *O*. *M* is on leveled space on hillside about 150 meters west of observatory grounds and about 100 meters south of group of three Arab houses built of rough stone; marked by tack in top of round wooden peg. True bearings. ornament on equatorial coudé, 261° 26′.8; Dome de Kouba, 6 kilometers, 322° 46′.7; monument to African soldiers, 2 kilometers, 330° 26′.8. *O* is pier in northwest part of observatory grounds, near grove of pines and about 60 meters distant from nearest building; the pier is a stone slab set in cement floor and surmounted by marble slab for instruments and covered with wooden shed. True bearing: Matifou lighthouse, 265° 28′.5.

Algiers, M_2, Algiers, 1912.—The station established by Mr. F. Baldet, of the Algiers Observatory, in January, 1912, was reoccupied; on first rising ground west of observatory, 99.5 feet (30.33 meters) northwest of well, 66 feet (20.1 meters) south of lone fig tree, about 200 feet (61 meters) east of grove of cultivated pine trees, about 60 meters southwest of southwest corner of Arab's house with flat roof, about 400 feet (122 meters) northwest of Arab's house with dome, and 6 feet (1.8 meters) west of abrupt slope; marked by wooden peg driven flush with ground. True bearings: Dome de Kouba, 322° 28′.6; monument to African soldiers, 329° 31′.6.

Bedeau, Oran, 1912.—North of village, three-quarters kilometer west of railroad, 34.5 meters south and 31 meters southwest respectively from west and south corners of cemetery wall; marked by wooden peg driven into soft stone. True bearings: vane on large white building in Bedeau, 8° 02′.2; cross on church in Bedeau, 359° 44′.0.

Beni-Ounif, Ain Sefra, 1912.—About three-quarters kilometer southwest of railroad station, in shallow wadi southwest of village, 200 meters west of stunted palm grove, 41.2 meters west of southwest corner of entrance of ruined mud brick building supposed to be sheepfold, marked by wooden peg driven flush with ground. True bearings· dome of Marabout of Sidi Sliman, 232° 27′.5, flagstaff on commandant's residence near railroad station, 246° 29′.5.

Biskra, Constantine, 1911.—On east bank of dry watercourse called Oued Biskra, south of native village Lallia and in range with Marabout Sidi Zafzour and ruins of what appears to be old bridge pier, 82 paces south of southeast end of native cemetery, 9.5 meters east of bank of Oued Biskra, 5 meters east-northeast of washout which is used by natives for descending into Oued Biskra, and 140 paces southwest of culvert which carries road over an irrigation ditch. True bearings: dome of Palais de Justice, 133° 32′.8; tower on Hotel Royal, 137° 30′.6.

Bougie, Constantine, 1911.—In northeastern part of drill grounds, west of Bougie and on road to Setif (Rue de Jeanne d'Arc); 36 meters south of road passing through drill grounds, 85 meters southwest of south corner of square stone building, and 12.2 meters west of more westerly one (marked 3) of two boundary stones which are in range with station, marked by tent peg driven flush with ground. True bearings: smoke-stack in valley to northward, 212° 38′.7; sign post at railroad crossing, 281° 24′.6.

Colomb-Bechar, Ain Sefra, 1912.—In small wadi to west of village, about 200 meters southwest of "Bureau Arabe," about 200 meters east of monument erected on hill to memory of soldiers who have fallen in South Algeria, 43.5 meters south of south corner of mud wall around palm grove, and 44.5 meters southwest of northwest corner of garden; marked by wooden peg driven flush with ground. True bearings: cross on church, 251° 02′.4; minaret of mosque, 343° 30′.2.

El-Guerrah, Constantine, 1911.—Southwest of Guettar-el-Ayech road and one-half kilometer northeast of junction of this road with Biskra road to northwest of railroad station; 60 meters southwest of 30-kilometer stone and 45 meters south-southwest of center of road; marked by tent peg driven flush with ground. True bearing· chimney of house with small square second story, 316° 32′.2.

Le Kreider, Oran, 1912.—On northeast edge of shallow ravine, about one-half kilometer north of railroad station, 400 paces northwest of bend in road leading up hill to fortress, and about 270 paces northeast of reservior; marked by wooden peg driven flush with ground. True bearings· spire on church, 42° 29′.9; flagstaff on tower of fortress, 312° 57′.9; dome on military barracks, 322° 47′.4

Nemours, Oran, 1912.—South of Nemours and about one-half kilometer southeast of seashore, on southwest side of sandy plain; in line with white rectangular house and lone tree, 45.5 meters west-northwest of tree and 103.5 meters east-southeast of entrance to house; marked by wooden peg driven flush with ground True bearings: spire on lighthouse, 103° 03′.2, spire of church in Nemours, 205° 09′.2.

Oran (Gambetta), Oran, 1912.—Very nearly the station of Moureaux of 1887 It is near site of old racecourse at Gambetta, about one-half kilometer north of electric railroad, 32 meters south of edge of bluff, 500 meters west of a masked battery on edge of bluff, 350 meters east of battery, 300 meters north of steam railroad, 200 meters north of ravine, and 51 meters southwest of fork of road; marked by wooden peg driven flush with ground. True bearings: clock tower on railroad station, 42° 41′.4; tower of chapel on mountain near old fort, 86° 02′.5.

Oran (new station), Oran, 1912.—Near rifle range, about 6 kilometers west of Oran, on road which runs westward along coast; 35 meters east of small pine on edge of bluff and 24 meters southwest of entrance to target pit. True bearings: clock tower of railroad station, 50° 28′.6; tower of Santa Cruz chapel on mountain near old fort, 68° 03′.6.

Orleansville, Algiers, 1912.—Near northeast corner of town wall, nearly opposite inclosed field used as cattle market, 200 meters south of Oued Chelif, and probably within 200 meters of station of 1887 by Moureaux; 21 meters southwest of milestone marked 8-15S on southwest side of Orleansville-Oued Chelif road, 51 meters northeast and 47 meters southeast respectively from southeast and northeast corners of military angle on city wall; marked by wooden peg driven flush with ground. True bearing: lightning-rod on smoke-stack, about 0.5 kilometer, 244° 34′.2.

AFRICA.

ALGERIA—*concluded.*

Philippeville, Constantine, 1911.—Southwest of Philippeville and its suburb Esperance, on northwest side of road to Constantine, in middle of branch road leading to Madame Pina's house; 49 0 meters southwest of old well and 19 2 meters north of tree standing on border of meadow and cultivated land; marked by tent peg driven flush with ground True bearings: middle minaret visible in front of M. Buono's house, 45° 03′ 7; middle chimney visible on Madame Ruden's house, 267° 31′.7.

Saida, Oran, 1912 —Probably within 300 or 400 meters of station of 1887 by Moureaux, which was not available on account of steel bridge across Oued Saida, on edge of small ravine on rifle range about 600 meters southwest of railroad station; 325 meters south of steel bridge, 200 meters west of Oued Saida, 145 paces west-southwest from Marabout 32 meters, west-southwest from wooden framework used in target practice, and about 200 meters north-northwest from rifle pit; marked by wooden peg driven flush with ground. True bearings: dome of Marabout at Negro village on west bank of Oued Saida, 241° 57′.4; minaret of mosque in Saida, 244° 15′.2, church tower in Saida, 259° 23′.6.

Setif, Constantine, 1911.—Near target embankment in north end of drill grounds, about one-half kilometer north of city walls and about 200 meters east of road to Bougie; 142 paces southwest of center of target pit and 12 meters northeast of square stone set in earth at corner of field, marked by a wooden peg driven flush with ground. True bearings: cross on St Augustine Church, 1° 39′.2; signal post, 278° 45′ 1.

Souk-Ahras, Constantine, 1911.—Southeast of Souk-Ahras, in meadow southeast of French Catholic cemetery, 4 meters east of terrace separating cultivated land from meadow, 43.5 meters southeast of cemetery wall, and 60 meters east of south corner of cemetery wall; marked by a tent peg driven flush with ground True bearings: tip of dome of Marabout of Sidi Mesaud, 148° 39′ 3; cupola on farmhouse Ancien Firme Renaldi, 263° 23′.7

Tiaret, Oran, 1912.—On uncultivated ground bounded on three sides by great vineyard, on hill west of town, near more southeasterly group of seven pines, about 55 paces southeast of northwesterly group of eight pines, and 14.1 meters south-southwest of most westerly tree of southeasterly group; marked by tent peg driven flush with ground. True bearings: main dome of Marabout of Sidi Raald, 162° 58′ 3; minaret of mosque in Tiaret, 193° 28′.4.

ALGERIAN SAHARA.[1]

Amselkat, 1913.—In wadi Tamanrasset, 163 feet (49.7 meters) west-northwest from the well Amselkat. True bearing: conical stone pile on top of cylindrical pile, three-fourths mile (1.2 kilometers), 60° 37′.0.

Arec Kanem, 1912 —At last encampment before reaching El-Golea, on a large sand drift extending northwest and southeast in last sand field encountered before El-Golea, in level region covered with rock. Inclination observations were made at a secondary station 100 feet (30.5 meters) east of main station

Berzique, 1912 —On open desert, about 150 meters northwest of the caravansary or bordj, and about 100 meters west of Touggourt caravan road. True bearings: north edge of square tower on north side of low building, distant about 6 kilometers, used as heliograph station, 243° 36′.0; southernmost lower edge of caravansary, 325° 55′ 8. Inclination observations were made at secondary station 160 feet (48.8 meters) east-northeast of main station in direction of heliograph tower.

[1] There are no descriptions for the following stations in Algerian Sahara Camp 5 from El-Golea, Camps 5 and 7 from Fort Miribel, Camps 2, 4, 8, 9, 10, 12, 16, 17, 18 (auxiliary), 19, 21, 31, 32, 33, 35, 38, and 44 from In-Salah, Dait Seddeur, Er-el-Aisha, Gouret-ed-Diab; Grun-el-Dehia, Hassi Metalla, Oued Tibrad; and Tegueneouen.

AFRICA.

ALGERIAN SAHARA—*continued.*

Camp 2 from El-Golea, 1912 —On soft ground in depression about 1 kilometer from trail marker, marked 42K, or about 41 kilometers south of El-Golea. Inclination observed at secondary station about 90 feet (27.4 meters) south of main station.

Camp 18 from In-Salah, 1913 —Several kilometers west of regular trail to Fort Motylinski, in Wadi Talaouaoud, and about 1 kilometer north of abandoned well of same name, near east side of wadi, 90 feet (27.4 meters) east of steep west bank of wadi.

Camp 27 from In-Salah, 1913 —In wadi at third regular caravan stop from Fort Motylinski to Kidal, about 150 feet (46 meters) from east edge of wadi, and 200 feet (61 meters) from west edge.

Dinissi, 1912.—At third encampment from Fort Miribel, on small tableland rising out of bed of ravine which contains the grazing, and which has precipitous sides and is, at times, a water course, in small, deep, wind-sheltered branch of main ravine, 16.7 feet (5.09 meters) west of bank, 50 feet (15 meters) southeast of round eroded hillock in branch ravine, about one-half kilometer northwest of prominent hill, and 3 or 4 kilometers south of transverse ridge.

El Bour N'Goussa, 1912 —Two stations, designated *A* and *B*, were occupied on unclaimed land among shifting sand dunes about one-fourth mile (0.4 kilometer) south of village *A* is about 400 meters south of Marabout of Sidi Abdul Kader, and about one-fourth mile (0 4 kilometer) southwest of Mosque of Bour, 219 feet (66 7 meters) and 193.5 feet (59 0 meters) respectively, northwest of two low square mud huts. True bearings: Marabout of Sidi Abdul Kader, 170° 51′.8; Mosque of Bour, 219° 36′ 2. *B* is 194 6 feet (59.31 meters) from *A* in reverse azimuth of Mosque of Bour.

El-Golea, 1912 —In wide street between palm gardens inclosed by mud walls, about three-fourths kilometer east of military quarters, about one-half kilometer west of conical hill upon which old town of El-Golea was situated, 77 5 feet (23 6 meters) southwest of mud wall at side of street, 73 feet (22.2 meters) northeast of opposite wall, marked by tent peg driven flush with ground. True bearings: dome on military quarters, 98° 45′.6; conical hill, old town, 243° 06′.2, conical hill without buildings, 304° 20′.8

Foggaret-ez-Zoua, 1912 —In scattered village of mud huts about 42 kilometers north of In-Salah, about 75 meters north of caravansary, about 200 meters northwest of low castellated building, about 300 meters west of marabout or tower erected to a saint, and 354 feet (108 meters) southwest of similar marabout. True bearing: pinnacle of marabout, 260° 22′.5. Inclination was observed at secondary station 135.5 feet (41.3 meters) east of main station.

Fort Miribel, 1912.—On sandy bottom of basin which affords water and grazing, about 0 2 kilometer south of fort, now abandoned, 143 feet (43 6 meters) southeast of lone palm tree, 7 feet (2.1 meters) beyond which in same line is mud-wall inclosure, and 160 feet (48.8 meters) south-southwest of end of mud wall partly in ruins; marked by tent peg driven flush with ground True bearings: pile of stones on horizon, about 2 kilometers, 75° 35′ 7; bisection of center gate at Fort Miribel, 171° 50′.6; east edge of guard house, 191° 44′.2; Marabout of Sidi Abdul Kader, center pinnacle, 327° 04′.2.

AFRICA.

ALGERIAN SAHARA—*continued.*

Fort Motylinski, 1913.—About 69 feet (21 meters) east of west bank of Wadi Tuckahaut, and 100 yards (91 meters) southwest of fort. True bearing: east edge of military rest house near foot of hill on which the fort stands, 254° 56'.2.

Hassi Amalaouly, 1913.—In Wadi Tamanrasset, about 250 feet (76 meters) east of well.

Hassi-el-Hadjar, 1912.—Two stations, designated *A* and *B*, were occupied. *A* is in slight ravine about three-fourths kilometer northwest of abandoned caravansary (bordj), 181.5 feet (55.32 meters) southwest of well (Hassi-el-Hadjar) which is 30 meters deep, west of rocky plateau, and north and east of sand dunes. True bearing: northeast corner of caravansary, 296° 34'.7. *B* is about 341 feet (104 meters) from *A* in the direction of northeast corner of caravansary.

Hassi-el-Khenig, 1913.—In ravine with very steep sides, about 300 yards (274 meters) northwest of wells at Hassi-el-Khenig.

Hassi-el-Meksa, 1912.—On sand dune about 50 meters west of the well, Hassi-el-Meksa. Inclination observations made at secondary station about 50 meters south of main station and a few meters west of enormous sand drifts.

Hassi Mahmar, 1912.—About 200 meters west of caravan road and telegraph line to Ouargla, 220 paces northeast of caravansary (bordj), about same distance north of small square house east of caravansary, and about 160 meters northwest of wall inclosing well. True bearing: east edge of caravansary, 31° 58'.6.

Hassi Meniet, 1913.—On pasturage in wadi about 2 kilometers north of well at Hassi Meniet.

In-Amguel, 1913.—At first Tuareg village encountered south of In-Salah, on south side of main valley of same name as village, in a spot surrounded by low hills, and 210 feet (64 meters) northwest of most westerly boulder at northeast end of small oblong mound.

In-Belrem, 1913.—About 800 feet (244 meters) north-northwest from well known as In-Belrem. The sand in this locality contains fine particles of magnetic material.

In-Salah, 1912.—On desert north of military buildings, about 300 meters north of mess hall, about 400 meters northwest of commandant's quarters, about 300 meters northeast of native sergeant's quarters, and about 100 meters south of sand dunes. True bearings: east edge of native sergeant's quarters, 39° 03'.6; east edge of commandant's quarters, 325° 35'.0; east edge of mess hall, 349° 17'.1.

Jarf-el-Bacra, 1912.—At third encampment from Hassi-el-Hadjar, about an hour's march north of pass of this name, 134 feet (40.8 meters) southeast of a pile of stones erected as a trail marker. Inclination observed at secondary station 70.5 feet (21.49 meters) northeast of main station.

Mousa-ben-Yaich, 1912.—At sixth encampment south of Fort Miribel, on elevation in dry bed of oued, about one-half kilometer south of intersection of Ouargla and El-Golea-In-Salah trails, and about three hours' march north of nearest well.

Ouargla, 1912.—On parade ground between town and fort, about 0.3 kilometer southeast of walls of town, about 75 meters east of native gardens with palm trees, and about 240 meters north of fort; marked by tent peg driven flush with ground. True bearings: Marabout of Sidi-el-Hadj Bahhouse, 62° 38'.0; south tower of two mosque towers near market place, 189° 33'.2; dome north of gate on Bureau Arabe, 304° 41'.0.

AFRICA.

ALGERIAN SAHARA—*continued.*

Steil, 1912.—Two stations, designated *A* and *B*, were occupied about 1 kilometer northeast of the caravansary or bordj at Steil. *A* is 200 feet (61.0 meters) west of caravan road, 245 feet (74.7 meters) west of railway (under construction), and 125 feet (38.1 meters) southwest of crest of small hillock; marked by tent peg driven flush with ground. True bearings: east edge of square tower on caravansary, 3 kilometers, 350° 40'.4; a similar tower, 351° 02'.8. *B* is 169 feet (51.5 meters) from *A*, on line toward distant caravansary.

Tabaloulet, 1912.—In bed of first small tributary that joins main ravine or Oued Tabaloulet from north just west of where trail enters ravine, 198.5 feet (60.50 meters) east of center of well (Hassi Tabaloulet), 70.0 feet (21.3 meters) west of large boulder lying at foot of steep hill east of ravine. True bearing: west point of large road marker on hill across main ravine, 322° 46'.0. Inclination observations made at secondary station 191.5 feet (58.37 meters) north of main station.

Tademi, 1913.—Near center of wadi, and 73.5 feet (22.4 meters) south of the well.

Takoubaret, 1913.—About 340 feet (104 meters) south-southwest from well Takoubaret, in canyon having walls about 200 feet (61 meters) high, 90 feet (27 meters) from northwest wall, and 210 feet (64 meters) from southeast wall. An auxiliary dip station was occupied 50 feet (15.2 meters) west of well.

Talanteidi, 1913.—Southeast of dense growth of cane where water comes to surface, and about 500 feet (152 meters) northeast of the well.

Tamanrasset, 1913.—In Wadi Tamanrasset, at village of same name, 250 feet (76 meters) southwest of ethel tree, about 1,000 feet (305 meters) northeast of mud house of French missionary; marked by tent peg driven flush with ground.

Taoun Tarak, 1913.—About 270 feet (82 meters) southwest of well in canyon, and 430 feet (131 meters) from east wall of canyon; marked by tent peg.

Tesnou, 1913.—On plain north of very large semicircular hill of solid granite known as Djebel Tesnou, 620 feet (189 meters) northeast of marabout of Moulay-Thassen, and 300 feet (91 meters) north of wadi; marked by tent peg driven flush with ground. True bearing: trail marker on two-peaked hill, 241° 13'.4.

Tilmas Ferkla, 1912.—On small elevated area of dried mud just west of present shallow well or "tilmas" which may be abandoned for new one at any time, south of branch which enters main ravine or oued, east of rocky hill which obstructs view toward west, about 75 meters south of northern edge and 30 meters west of eastern edge of elevated area. True bearing: road marker on distant hill, 169° 25'.7.

Tin-Zaouaten, 1913.—About 400 yards (366 meters) southwest of French military depot Tin-Zaouaten, 75 yards (69 meters) north-northeast from southwest edge of wadi, 125 yards (114 meters) south-southwest from lone tree in wadi, and about one-fourth kilometer west-northwest from well which supplies the military depot with water; marked by tent peg driven flush with sand. True bearing: east edge of military depot, 237° 02'.0.

Tit, 1913.—South of the Tuareg village, 107 feet (32.6 meters) southeast of reed hut, 300 feet (91 meters) west-northwest of reed military shelter, 4 kilometers southwest of goat corral, and 250 feet (76 meters) east of conical rock peak. True bearing: east edge of goat corral, 233° 55'.4. An auxiliary dip station was established 250 feet (76.2 meters) west of main station. At this place the sand is very magnetic.

AFRICA.

ALGERIAN SAHARA—*concluded.*

Touggourt, 1912.—About 1 mile (1.6 kilometers) north of village, 350 feet (107 meters) east of caravan route to Biskra, on top of barren roll of hard sand north of old brickyard; marked by peg set flush with ground. True bearings: center spire on tower of Arabic mosque of Touggourt, 24° 36′.7; north dome of Marabout of Zawit Imnuawar, 218° 30′.3; Arabic mosque of Tebesbest, 300° 45′.3.

ANGLO-EGYPTIAN SUDAN.

Port Sudan, 1911.—About 1 kilometer north of Port Sudan harbor; 65 meters south-southwest of small frame house used for storing targets, 49 meters south of sand embankment used for blocking bullets, and 49 meters south-southeast of a target pit; marked by wooden stake driven flush with ground. True bearings: lightning rod on smokestack at harbor, 24° 23′.9; light tower at entrance to harbor, 358° 30′.2.

Suakin, 1911.—About 220 paces east of southeast corner of English cemetery, 200 paces south of quarantine station fence, and 85 paces north of water's edge; marked by wooden stake driven flush with ground. True bearings: more easterly of two minarets visible in Suakin, 42° 18′.5; more westerly of two minarets visible in Suakin, 43° 27′.1.

BRITISH SOUTH AND CENTRAL AFRICA.

Cape Town, Cape Colony, 1911.—Four stations, *A*, *B*, *C*, and *D*, all in line with bottom of weather vane on hospital tower, were established in field belonging to the Valkenberg Mental Hospital; the field is back of North Lodge and bounded on north and west by Royal Astronomical Observatory, with avenue along western boundary leading to hospital. Main station, *A*, is one-third kilometer northwest of hospital, 273 feet (83.2 meters) from fence bounding avenue to westward and same distance from fence bounding field to southward; marked by wood post projecting about 2 feet 6 inches (76 cm.) above ground, center of post marking exact point. True bearings: triangulation mark on Devil's Peak, 3 kilometers, 60° 06′.9; gable of lodge, 127° 08′.6; bottom of weather vane on hospital tower, 318° 11′.8. *B* is 98.4 feet (29.99 meters) nearer hospital than *A*. *C* is 90.7 feet (27.65 meters) farther from hospital than *A*. *D* is 181.6 feet (55.35 meters) farther from hospital than *A*.

EGYPT.

Helwan Observatory, 1911.—Comparison observations in horizontal intensity and declination were made on north pier, designated *N*, in main observatory building, and at stone pier, designated *H*, in small wooden hut about 150 feet (46 meters) southwest of main observatory; dip comparisons were made at *H* and on south pier, designated *S*, in main observatory.

Suez, 1911.—Station of 1908 on low desert west of town of Suez was reoccupied. It is 320 paces east of east wall of slaughter pen and 115 meters north of north wall of brick dwelling-house near old lighthouse; marked by intersection of cross on head of brass bolt set in top of sandstone post 20 by 25 by 80 cm. projecting 5 cm. above ground. True bearings: minaret of Mosque Ibrahim Bey Gilidan, 213° 54′.8; minaret of Abul-Eef Mosque, 238° 32′.2; spire of church in Port Tewfik, 313° 13′.4.

Tor, 1911.—On sandy spit opposite village and northwest of quarantine station and jetties, 38 paces due east of water's edge and 225 paces west-northwest from pile of coral stones; marked by wooden stake. True bearings: minaret in northwest part of village of Tor, 231° 46′.0, minaret in southeast part of Tor, 241° 11′.3.

AFRICA.

ERITREA.

Massawa, 1911.—On south end of Taoualand Island, which is connected with Massawa Island by causeway, on that portion of island used as rifle range, 42 and 44 meters northeast from east and west sand mounds used for rifle practice, and 51.5 and 54.2 meters southwest from southeast and southwest corners of covered shed used in target practice; there are two larger sand banks similarly fitted out to southwestward; marked by wooden peg driven flush with ground. True bearings: minaret in Massawa, 224° 50′.2; Ras Mudir lighthouse, 233° 39′.8.

FRENCH WEST AFRICA [1]

Ansongo, Upper Senegal and Niger, 1913.—On east bank of Niger River, on south side of road leading from water front, about 100 yards (91 meters) south of rear of French Residence, 104.3 feet (31.8 meters) northwest from thorn tree, 150 meters east of market on river bank, 166.3 feet (50.7 meters) southeast of thorn tree on edge of road, and 62 feet (18.9 meters) south of middle of road. True bearings: east edge of market building, 54° 27′.9; middle one of three rocks in river, 72° 53′.8; east edge of French Residence, 111° 37′.2.

Bakel, Senegal, 1913.—On west bank of Senegal River, about in line with center of third street north of one on which post office is located, 62.5 feet (19.05 meters) east of small cotton tree, 95.8 feet (29.20 meters) north of large cotton tree, and 20 feet (6.1 meters) west of edge of bank of river; marked by painted stone projecting about 3 inches (8 cm.) above ground. True bearings: steel channel marker with white face, 192° 26′.7; steel channel marker with white face, 202° 18′.1; steel channel marker with black face directly across river, 269° 54′.6.

Bamba, Upper Senegal and Niger, 1913.—On north end of island in Niger River, about 1.5 miles (2.4 kilometers) southwest of village of Bamba, 500 feet (152 meters) from north end of island, and 150 feet (46 meters) west of main channel; marked by tent peg driven flush with ground.

Bambereke, Dahomey, 1913.—In open space in front of administration buildings, 75.7 feet (23.07 meters) south of administration house, 116 feet (35.4 meters) northeast of administration office building, and about 150 feet (46 meters) north of auto-bus shed; marked temporarily by peg driven flush with ground, the administration authorities volunteering to mark the station permanently by stone or cement pier. True bearing: west edge of auto-bus shed, 353° 11′.0.

Bohicon, Dahomey, 1913.—About 1 kilometer northwest of town, 37.9 feet (11.55 meters) east of middle of road to Pomia, 170 feet (51.8 meters) southwest of large lone tree, about 100 yards (91 meters) southeast of palm forest, and 77.3 feet (23.56 meters) northwest of large tree, marked by tent peg driven flush with ground.

Bosia, Upper Senegal and Niger, 1913.—About 50 yards (46 meters) east of Niger River, 100 yards (91 meters) west of native village, 100 yards (91 meters) south of peculiar stratified hill, and 262 feet (79.9 meters) and 267.6 feet (81.57 meters) respectively northwest and west-northwest from trees.

Bourem, Upper Senegal and Niger, 1913.—On east bank of Niger River, about three-fourths kilometer south-southwest of fort, about three-fourths kilometer west-southwest from gardens of post, and 12 feet (3.7 meters) eastward from edge of bank; marked by tent peg driven flush with ground. True bearing: west edge of fort, 214° 15′.8.

[1] There are no descriptions for the following stations in French West Africa: Camps 48 and 53 from In-Salah, Camp 6 from Kidal, In-Tassik, and Oued Eguerer.

AFRICA.

FRENCH WEST AFRICA—*continued.*

Cape Blanco, Mauretania, 1912.—Near end of cape, 250 meters south-southwest of lighthouse, 166 paces northeast of column of stones, about 2 meters high, on brow of cliff; marked by tent peg driven flush and covered over with sand. True bearings: weather vane on lighthouse tower, 239° 14′.4; semaphore south of lighthouse, 248° 02′.8

Conakry, French Guinea, 1912.—On spit of land projecting southeast from east side of Peninsula of Conakry, 1 kilometer south of wireless station, about 1.5 kilometers east of marble pyramid erected by Service Géographique in 1905, in vicinity of hospital and within a few feet of high-water mark, 32.2 feet (9.81 meters) east, 29.7 feet (9.05 meters) west, 65 feet (19.8 meters) southeast, and 54 feet (16.5 meters) north-northwest respectively from projecting rocks.

Cotonou, Dahomey, 1913.—Approximately a reoccupation of Mission Tilho station of 1906; about 400 yards (366 meters) southwest of railroad repair shops and engine houses, about 1 kilometer west of town of Cotonou, 20.4 feet (6.22 meters) north of Ouidah road, 380 feet (116 meters) east of cement aqueduct on Ouidah road, and about 200 yards (183 meters) north of seashore; marked by tent peg driven flush with ground. True bearings: smokestack of railroad shops, 229° 01′.5; flagstaff on Noemann Co., 271° 33′.4.

Dakar, Senegal, 1912, 1913.—North of town, in new cemetery, on point of land known as Bel-Air, about 1.8 kilometers northeast of electric power house, and 114 meters and 139.5 meters respectively from west and south corners of old cemetery, and 53 paces east of west corner of new cemetery cement wall; marked by tent peg driven flush with ground and covered with earth. True bearings: dome on Governor-General's palace, 11° 36′.9; lighthouse (Phare de Mamelles), 107° 41′.8; brick chimney of pumping station, 159° 49′.6; spire on porters' lodge north of gate, 318° 34′.7.

Gao, Upper Senegal and Niger, 1913.—In courtyard of fort, 18.0 feet (5.49 meters) from wall of sergeant's quarters, 28.8 feet (8.78 meters) northeast of northwest corner of sergeant's quarters, 84.0 feet (25.60 meters) southeast of south corner of Bureau Arabe, 75.2 feet (22.92 meters) south-southwest from southwest corner of carpenter shop, 2.9 feet (88 cm.) southward from brick pier, and 5 feet (1.5 meters) from nearest small tree. A secondary station was established 1,127 feet (343.5 meters) east of main station.

Gaya, Military Territory of the Niger, 1913.—Approximately a reoccupation of Mission Tilho station of 1907, 36.3 feet (11.06 meters) south-southwest of east edge of officers' quarters in camp for travelers, 132 feet (40.2 meters) north-northeast of large tamarind tree, and approximately in line between the tamarind tree and corner of officers' quarters; marked by tent peg driven flush with ground. True bearings: tamarind tree, 15° 18′.6; flagstaff on administration building, about 200 yards (183 meters), 138° 48′.2.

Goum Goum, Dahomey, 1913.—Two days' march from Niger River near native village; 74.1 feet (22.59 meters) east of middle entrance of central hut of encampment for travelers, west of native village, and 45 feet (13.7 meters) east of large lone tree, marked by tent peg driven flush with ground. True bearing: entrance to hut, 107° 05′.

Gourao, Upper Senegal and Niger, 1913.—In central village of this name, on low hill on shore of Lake Debou, north of heavy ledge of rocks, and north of a path, 65 feet (19.8 meters) and 61 feet (18.6 meters) respectively southwest and west-southwest from two large trees standing about 20 feet (6 meters) apart; marked by tent peg.

Hassi Bou-Ghassa, Military Territory of the Niger, 1913.—In wadi at Hassi Bou-Ghassa, 755 feet (230 meters) south of well, 359 feet (109 meters) south of lone tree, about 900 feet (274 meters) southwest of trail marker on north edge of wadi, 259 feet (79 meters) southwest of abandoned well, 82 feet (25 meters) north of pile of large rocks, and about 650 feet (198 meters) north of south edge of wadi; marked by tent peg driven flush with ground. True bearing: perpendicular face of rock on ridge forming south boundary of wadi, 47° 59′.0.

Hassi Yerlick (Arhli), Military Territory of the Niger, 1913.—About center of wadi at Hassi Yerlick, about 150 yards (137 meters) southwest of main well, 549 feet (167 meters) southwest of lone tree, and 227.5 feet (69.35 meters) east-northeast from lone tree.

Kandi, Dahomey, 1913.—Approximately a reoccupation of 1906 station of Mission Tilho; in yard of abandoned military post now used as encampment for travelers, 107 feet (32.6 meters) from former quarters of commandant, and 67 feet (20 meters) north of huts of old military quarters.

Kaolack, Senegal, 1912.—In large unoccupied square in front of administrator's residence, about 350 meters east of railroad station, 236 paces south-southeast of entrance into garden of administrator's residence, 104.5 meters southwest of center of front end of market building, 54.2 meters south-southwest of well in center of square, and 42 meters east of center of road; marked by tent peg driven flush with ground and covered with earth. True bearings: ornament on south end of railroad station, 91° 25′.2; ornament on west gable of market building, 242° 11′.5.

Kayes, Upper Senegal and Niger, 1913.—Eastward of public buildings, between Avenue Ballay and Senegal River, about in line with center of Rue du Lieutenant Carnier, 75.4 feet (22.98 meters) north of seawall, and 19.5 feet (5.94 meters) south of point where river bank begins sharp drop to river; marked by monument of rough stone laid in cement, 30 cm. square and projecting 40 cm. above ground, lettered "CIW 1913."

Keé, Upper Senegal and Niger, 1913.—Near south edge of small plateau on east end of large island in Niger River and to northeast of Keé, this plateau being site of abandoned village now in ruins.

Kidal, Military Territory of the Niger, 1913.—On northeast bank of Wadi Eguerer, about 160 feet (49 meters) southeast of east gate of brush fence inclosing post, 26.5 feet (8.1 meters) south-southeast from nearest rock, 24 feet (7.3 meters) due west of small rock, and 142 feet (43.3 meters) north-northeast from cocoanut tree with four large trunks, marked by large tent peg driven flush with ground. True bearings: south corner of prison, storehouse, and office 98° 45′.5; south corner of lieutenant's house, 105° 46′.0; west corner of post, 148° 58′.0; east corner of post, 152° 31′.5.

Kilibo, Dahomey, 1913.—In open space at north end of native village, 195 feet (59.4 meters) east of middle of Savé road, 40.3 feet (12.28 meters) southeast of lone tree, 32.6 feet (9.94 meters) northeast of north corner of mud wall, and about due east of store of a European trader on west side of road; marked by tent peg driven flush with ground.

AFRICA.

FRENCH WEST AFRICA—*continued*

Kindia, French Guinea, 1912.—About 1 kilometer north of town, in open tract on right-hand side of main road, 47 3 feet (14 4 meters) southeast of tree on north side of path, 147 7 feet (45 0 meters) southwest of tree, about 0.4 kilometer southwest of large palm tree, 133.2 feet (40 6 meters) west of lone tree, about 1 kilometer north of lone blazed tree near railway buffet, about 1 5 kilometers northeast of square water tank, and 120 feet (36.6 meters) east of tree east of main road, marked by peg driven flush with ground True bearings: edge of water tank, 27° 33′ 1, lone palm tree near road, 253° 53′, blazed tree near buffet, 356° 23′.

Kita, Upper Senegal and Niger, 1913 —Southwest of grounds surrounding offices and residence of commander, 53.4 feet (16 28 meters) southwest from point on fence which is 53.6 feet (16.34 meters) southeast of west entrance to grounds, 47.0 feet (14.33 meters) southwest from tree near fence at same point, 64 4 feet (19.63 meters) southeast from tree on south side of drive, and 98.2 feet (29 93 meters) northeast from tree on northeast side of street which parallels the fence; marked by tent peg driven flush with ground.

Koulikoro, Upper Senegal and Niger, 1913.—On left bank of Niger River, on ledge of solid rock on first terrace below telegraph office and house of commander, 60 feet (18 3 meters) southwest from center of road leading up hill 20 feet (6 meters) northwest from edge of ledge, and 198 feet (60.4 meters) northeast from telegraph line; marked by deep cross in top of granite post 8 inches (20 cm.) square set in concrete bed 6 inches (15 cm.) deep and 3 feet (91 cm) in diameter, edge of bed being lettered "Point astronomique 1905."

Koumpentoum, Senegal, 1912 —In meadow about 350 meters north of railroad, 70 meters west-southwest from south corner of negro village, 95 meters, 49 meters and 57 meters respectively southeast, south-southwest, and northwest from very large trees; marked by tent peg driven flush with ground and covered with earth True bearing post at north corner of house of chief construction engineer, 200 meters, 7° 36′.1

Mahina, Upper Senegal and Niger, 1913.—On west bank of Bafing River, 4 miles (6 kilometers) above point where Bafing and Bakoye Rivers unite to form the Senegal; 54 5 feet (16.61 meters) west of monument marking railroad right of way, 338 0 feet (103 02 meters) north of point in center of main line track which is 105 feet (32 0 meters) west of center of standpipe; marked by tent peg

Mamou, French Guinea, 1912.—About 1 kilometer south of railway station, on hillside opposite European section of town, 18 feet (5.5 meters) east of path leading toward hospital, 72 3 feet (22 0 meters) south-southeast of 3-foot (1-meter) stump, 140 feet (43 meters) west-southwest of tall tree; marked by peg driven flush with ground. True bearing: pinnacle on red-tiled building, 215° 52′ 4.

Matam, Senegal, 1913.—On west bank of Niger River, 372.5 feet (113.54 meters) east of market, 212.6 feet (64.80 meters) northeast of monument marking lot corner, about one-half mile (0 8 kilometer) south of main village, and about 800 feet (244 meters) south of de Vansaay's station of 1895, marked by brick monument 12 by 14 inches (30 by 36 cm.) projecting 1 foot (30 cm.) above ground.

Mopti, Upper Senegal and Niger, 1913.—On south bank of Niger River, on north edge of town, near houses and offices of French officials, 101 feet (30 8 meters) west-northwest from large cocoanut palm, 20.5 feet (6 25 meters) northeast of small date palm, 128.0 feet (36.82

AFRICA.

FRENCH WEST AFRICA—*continued*.

Mopti, Upper Senegal and Niger, 1913—continued.
meters) north of mud wall surrounding flower garden; marked by cross in sandstone post 6 by 6 by 18 inches (15 by 15 by 46 cm.).

Niafunké, Upper Senegal and Niger, 1913.—On north bank of Niger River, 41 feet (12.5 meters) north of stick and mud house, 59 5 feet (18.14 meters) and 54 8 feet (16 70 meters) respectively from northwest and northeast corners of house, 195.5 feet (59 59 meters) east of southeast corner of commander's residence, 178.2 feet (54.32 meters) west of southwest corner of bureau, and 2 4 feet (73 cm) east and 5 feet (1 52 meters) north from northeast corner of brick and cement pier used by Captains Jordan and Harranger in 1911 for astronomical work; marked by stake

Niamey, Upper Senegal and Niger, 1913.—Approximately a reoccupation of Mission Tilho station of 1908; on high rock-faced bluff on left bank of Niger River, 61 feet (18 6 meters) east of projecting corner of mud fortress, about 200 feet (61 meters) north of doctor's house, 100 yards (91 meters) south of administration house, 200 feet (61 meters) north-northwest of steel pole, about 180 feet (55 meters) east of Niger River, and 29.0 feet (8 84 meters) and 32.2 feet (9 81 meters) respectively southeast and southwest from small trees

Paraku, Dahomey, 1913 —About 50 yards (46 meters) southwest of 1906 station of Mission Tilho; 125 feet (38 1 meters) east of Niger-Savé road, 35 feet (10 7 meters) south of center of street which makes a right angle with Niger-Savé road, 147.2 feet (44.86 meters) southeast of corner of wall inclosing administration house, 83 feet (25 meters) southwest of hedge inclosing infirmary, about 48 yards (44 meters) northwest of vaccination hut, and about 50 yards (46 meters) northeast of post office, marked temporarily by peg driven flush with ground, the administration authorities volunteering to erect stone or cement pier. True bearing: gateway at entrance grounds of administration buildings, 110° 26′.

Podor, Senegal, 1913 —At northwest corner of street intersection southwest of fort, 12 feet (3.7 meters) north of monument in north line of street running east and west, probably 50 feet (15 2 meters) southwest of de Vansaay's station of 1895; marked by brick monument which marks lot corner and west line of street. True bearing: flagpole on main building at fort, 210° 09′.4.

Portendick, Mauretania, 1912.—About 8 miles (13 kilometers) above abandoned trading post of Portendick, about 6 miles (10 kilometers) south of Angel Hillocks, and 2.5 miles (4 kilometers) south of iron hulk of wrecked vessel, 130 paces east of shore line; marked by tent peg driven flush with ground and covered with sand.

Rapids of Labbezanga, Upper Senegal and Niger, 1913 —On Labbezanga Island, 75 yards (69 meters) south of bank of Niger River, about 100 yards (91 meters) southeast of rapids, 123.5 feet (37.65 meters) southeast of lone tree, and 92.5 feet (28.19 meters) northwest of small tree

St Louis, Senegal, 1912.—On west bank of Little Senegal River, about 2 miles (3 kilometers) north of de Vansaay's station of 1895, three-fourths kilometer south of lone palm tree on beach, 31.5 meters west of river bank, 300 paces southeast of two red-tile-roofed houses near young palm grove, and 192 paces southeast of garden inclosed by reed fence; marked by tent peg driven flush with ground and covered with earth True bearings: middle spire on civil hospital in St Louis, 0° 33′.1; church spire on Sohr Island, 325° 32′.6; flagpole on lighthouse in St. Louis, 357° 16′.6.

AFRICA.

FRENCH WEST AFRICA—*concluded*

Savé, Dahomey, 1913.—About 100 yards (91 meters) south of administration building 113.3 feet (34 53 meters) southeast of Cotonou Road, 56 feet (17.1 meters) southeast of northeast corner of cattle shed on roadside, and about 1 kilometer southwest of ridge of four prominent knobs of solid rock; marked by tent peg driven flush with ground True bearings: west edge of administration building, 183° 39′.7; second rock knob from north end of ridge, 233° 28′ 7.

Say, Upper Senegal and Niger, 1913.—About 80 feet (24 meters) from west bank of Niger River, 200 yards (183 meters) southeast of French Residence, about 124 feet (38 meters) south of main street of village, and 288 feet (87.8 meters) east of lone tree; marked by tent peg driven flush with ground. True bearing: south edge of official residence, 159° 24′ 0

Segou, Upper Senegal and Niger, 1913.—Above boat landing and near water's edge, 35 feet (10 7 meters) north of northeast corner of mud fence surrounding the Hotel de Passage, and 74 2 feet (23.17 meters) west-southwest from top of river gage; marked by black stone set in ground. True bearing: small steel tower marking rocks in middle of river, one-half mile (0.8 kilometer), 232° 48′ 2.

Tillabery, Military Territory of the Niger, 1913.—On Garicy Island in Niger River, about 1 mile (1.6 kilometers) west of military post of Tillabery, about 100 yards (91 meters) east of west shore of island, 200 feet (61 meters) south of north shore of island, and 123.2 feet (37.55 meters) and 111.7 feet (34 05 meters) respectively north-northeast and west-northwest from two large conspicuous trees.

Timbuktu, Upper Senegal and Niger, 1913.—Two stations, designated *A* and *B*, were occupied in front of barracks. *A* is 14 feet (4.3 meters) south-southwest from astronomical pier used by French Geographical Service, 222 5 feet (67.82 meters) southwest of corner of large house on street corner, about 100 yards (91 meters) east of Senegalese barracks, about 100 yards (91 meters) west of house of civil commandant, and about 100 yards (91 meters) northwest of administration building; marked by tent peg driven flush with ground. *B* is 405 feet (123.4 meters) south-southeast from *A*.

Yoro, Upper Senegal and Niger, 1913.—On east bank of Niger River, near native village of Yoro, 100 feet (30 meters) from river at low water; marked by tent peg driven flush with ground

GAMBIA.

Bathurst, A, 1912.—About 350 meters west from barracks of West African Frontier Force, and northeast of rifle range, on open tract of sand which is only land in vicinity not submerged at times; about 15 paces from line of brush to southwest, 56 paces to northeast, and 60 paces to northwest, marked by tent peg driven flush with ground. True bearings: flagpole at Government Place, 273° 00′.7; peak of gable of second West African Frontier Force barracks from north, 280° 51′.7.

Bathurst, B, 1912, 1913.—About 250 meters southwest of town, on narrow strip of land east of river, 32.5 feet (9.9 meters) east of brush bordering river, 213.6 feet (65.1 meters) southeast of walled well, and one-fourth mile (0 4 kilometer) southeast from Bathurst *A*. True bearing: vane on top of building, about 1 mile (1 6 kilometers), 211° 59′.4.

AFRICA.

LIBERIA.

Grand Basa, Basa, 1913 —On point of beach southwest of Grand Basa about 300 yards (274 meters) northeast of lighthouse, and about 10 feet (3 meters) from water at high tide True bearings lighthouse, 57° 39′ 4; flagpole of Woermann factory, 221° 53′ 2; steeple of Methodist church, 223° 10′ 7, steeple of the African Methodist Episcopal church, 228° 01′ 3.

Greenville (Sino), Sino, 1913, 1914 —On sandy beach about 40 feet (12 meters) from water at low tide and about 100 feet (30 meters) north of north edge of west end of street terminating at Government custom house at its east end True bearing Woermann flagpole, 347° 49′.5 The post office here is officially designated Greenville, but the transportation companies generally call the town Sino

Monrovia, Montserrado, 1913 —At center of west end of Broad Street, 4 feet (1 2 meters) from where steep and stony bank descends to river, marked by a wood stake. True bearings flagstaff nearest keeper's house on lighthouse, 109° 20′ 9; flagpole of Legislative Hall, 112° 10′.5.

Sino (Greenville), Sino, 1913, 1914.—See Greenville

MOROCCO

Cape Bojador, 1912.—On shore of semicircular bay, 56 paces back from edge of bluff, which at this point is about 20 meters high, in desert region, though there is a good well of water about 5 kilometers inland.

Cape Juby, 1912.—On beach south of more eastern of two old stone houses built by North African Trading Co , 200 paces east of shore and 121 paces south of conical tower at south corner of wall around stone house. True bearings. flagpole on more western of stone houses, about 1 2 kilometers, 120° 30′.0; conical tower, 190° 30′.8.

Cape Nachtigal, 1912 —At point on coast marked by small reef and semicircular plain on shore upon which are remains of old settlement called Medano Grande by the fishermen; 118 paces back from shore and 194 paces south of ruins of old stone house at north end of former settlement.

Casablanca, 1912.—About 3 kilometers south of Casablanca, on property of Hady Omar Tazi, ex-Prime Minister of Morocco, in level field adjacent to property of Abraham Ezezer; 327 feet (99 7 meters) southeast of west corner of wall in course of construction bounding Mr. Ezezer's property, 185 feet (56 4 meters) southwest of east corner of same wall, and about 80 feet (24.4 meters) west of cactus hedge forming portion of boundary. True bearings: tower of El-Calif, 150° 19′.9; easternmost wireless tower, 169° 59′.8.

Laraish, 1912.—Two stations, designated *A* and *B*, were established about 1 kilometer southwest of Laraish, in field belonging to Mr. Guagnino, almost surrounded by cactus hedges, on opposite side of road from property of Duke of Vernes. *A* is in eastern part of field, 70 meters southwest of large square white house of Duke of Vernes, 32 meters southwest of road, and 17.5 meters southwest of more southwesterly of two fig trees; marked by wooden peg driven flush with ground. True bearings. wireless telegraph tower, 85° 11′.2; flagpole, 0 8 kilometer distant, 184° 30′ 8 *B* is 42 meters northwest of *A*, 26 meters from cactus hedge on north, 25 meters from cactus hedge to west, 7 5 meters northwest of lone fig tree, and 74 meters from road; marked by wooden peg driven flush with ground. True bearings. wireless tower, 83° 50′ 5, flagpole, 0 8 kilometer, 191° 56′.5.

AFRICA.

MOROCCO—*continued*

Mazagan, 1912.—On southern edge of town, on property of Mr. T. Spinney, British vice-consul, in walled-in field on opposite side of road from Mr. Gruer's house, 175 feet (53.3 meters) east of entrance gate to field, 325 feet (99.1 meters) southeast of northwest corner of inclosure, 244.3 feet (74.5 meters) southwest of walled-up gate, and 193.5 feet (59.0 meters) northwest of projecting corner of wall about field. True bearings: tower of Jamma-el-Kebir, 157° 57′.2; flagpole on French consulate, 188° 00′.0.

Melilla, 1912.—In valley several kilometers west of port, about three-quarters kilometer west of brick factory; in plot of uncultivated ground between two gardens which are inclosed by stone walls, 75 paces west of farmhouse belonging to Francisco Esgleas, 23 meters southeast from clump of seven olive trees in garden on north, 38.5 meters southeast from clump of three olive trees in same garden, and 4.2 meters south of garden wall; marked by wooden peg driven flush with ground. True bearings: flag on fort, about 1.2 kilometers, 233° 18′.4, wireless telegraph station pole, 257° 55′.4.

Mogador, 1912.—The station is about 1.5 miles (2.4 kilometers) from Mogador, on Moorish Government property at place known as Taffa, on side of Marackish Gate and to left of beaten traversed ground; almost on beach, 120.5 feet (36.73 meters) south of hummock, 90.2 feet (28.04 meters) west of hummock on bank running roughly parallel with shore, 137.1 feet (41.78 meters) north of hummock, and 52.8 feet (16.09 meters) east of bank running about parallel with shore. True bearings: easternmost wireless tower, 40° 15′.0, tower of Hait-el-Reht, 45° 19′.2.

Rabat, 1912.—About 1.5 kilometers southwest of Rabat, on property of M. Leriche, French consul, 92 feet (28.0 meters) northeast of hedge on edge of road, 106.5 feet (32.46 meters) north-northeast of corner of hedge at end of field, 62 feet (18.9 meters) northwest of lone fig tree, and 250 feet (76.2 meters) north of house of M. Leriche; marked by wooden peg driven flush with ground. True bearings: tower of Mulai Sleiman, 94° 31′.2; tower of Hassani, 184° 32′.0.

Saffi, 1912.—The station is three-quarters mile (1.2 kilometers) southeast of town on Moorish Government property, on flat top of circular hill and southeast of hill on which there is large Jewish cemetery; 122.6 feet (37.37 meters) east-southeast from flat limestone rock almost flush with ground and in range with town, 143.2 feet (43.65 meters) west-southwest from hummock, 147.1 feet (44.84 meters) southwest of second hummock, about 150 yards (137 meters) northeast of limekiln, and about 200 yards (183 meters) northwest of Moorish huts. True bearings: police barracks, west edge, 70° 54′.4; tower of German consulate, east edge, 141° 26′.4.

Tangier, 1912.—Two stations, designated *A* and *B*, were established about 1.5 miles (2.4 kilometers) west of Tangier, on south side of Wadi Lihud or Jew's River. *A* is in pasture on hillside, 14.0 meters west-southwest of tree at southwest end of row of twelve cedars forming part of southeast boundary of property of Mr. Levison; marked by wooden peg driven flush with ground. True bearings: ornament on pinnacle of roof of Mr Levison's house, about 300 meters, 157° 50′.8; ornament on white tower with red tiled roof, 211° 49′.4. *B* is 50.5 meters east of *A*, 38 meters east-southeast and 31 meters south-southwest respectively from trees at southwest and northeast ends of row of twelve cedars; marked by wooden peg driven flush with ground.

MOROCCO—*concluded.*

Tangier, 1912—continued.
True bearings: ornament on pinnacle of roof of Mr Levison's house, 149° 41′.7; ornament on white tower with red tiled roof, 210° 15′.6.

NIGERIA.

Lagos, Lagos, 1913.—Observations were made over a pier of Southern Nigerian Survey marked $\frac{220\text{P}}{\circ\, 1\text{KP}}$, 20 chains (402.3 meters) north of Lagos Observatory and about 2 miles (3 kilometers) from Jones Hotel. True bearing: line marker, 180° 00′.2. [When reoccupied in March 1914, it was found that the marker-bolt in the pier is of iron one inch in diameter and at least 12 inches long; distance from top of bolt to magnet when making observations was about 4 feet.]

PORTUGUESE GUINEA.

Bissao, 1913.—On western end of Rey Island in river opposite Bissao, 290 feet (88.4 meters) eastward along path towards powder magazine from only well on island, near branch path to north, 38.8 feet (11.83 meters) north, 92.6 feet (28.22 meters) east, and 65.6 feet (19.99 meters) southeast of large trees; marked by wood stake. True bearings: lighthouse, 41° 33′.0; west lightning rod on powder magazine, 237° 21′.9.

Bulama, 1913.—On mainland across river from Bulama, about 300 yards (274 meters) north of terminal station of telegraph line to interior. True bearing: water tower in Bulama, 84° 46′.0.

RIO DE ORO.

Cape Corveiro, 1912.—On south side of Cape Corveiro, on northwest side of small bay, called on British Admiralty chart Puerto Nuevo, on beach near three large boulders, one of which stands in sea, 13.5 meters east of middle boulder, 12.5 meters north of high-water line, and 9.5 meters west of sand dune covered with vegetation; marked by peg covered with sand.

Villa Cisneros, 1912.—About two-thirds kilometer south of fort, in line between two monuments erected to indicate anchorage, 70 paces west of monument on seashore, and about 300 paces east of monument at Christian cemetery; marked by peg driven flush and covered with sand. True bearings: monument at cemetery, 83° 23′.9; flagpole on main building at fort, 216° 01′.0; monument on seashore, 266° 49′.6.

SIERRA LEONE.

Baiima, 1912.—About 1 mile (1.6 kilometers) south-southeast from town, in rice field on south side of best road leading into village; marked by tent peg driven flush with ground.

Bo, 1912.—About three-fourths mile (1.2 kilometers) north of railway station, in compound of English Methodist Mission, about 300 feet (91 meters) west of mission house, 20 feet (6.1 meters) from northwest boundary fence, 50 feet (15.2 meters) south-southwest from tree about 2 feet (0.6 meter) outside of fence, and 47.5 feet (14.48 meters) north from palm tree, marked by tent peg driven flush with ground. True bearings: palm tree, about 1 mile (1.6 kilometers), 73° 37′.1; vane on mission, 281° 29′.1.

Freetown, 1911.—At center of artillery parade ground on King Tom Peninsula, a little south of path running through grounds from east to west, and in line with north wall of stone barracks on west edge of parade ground, 241 feet (73.5 meters) from northeast corner of barracks, and 39 feet (11.9 meters) south of center of path, marked by small wood peg. True bearing: northeast corner of barracks, 90° 40′.3.

AFRICA.

SIERRA LEONE—*concluded.*

Freetown, 1912.—In artillery parade ground on King Tom Peninsula, about 200 yards (183 meters) northwest of C. I. W. station of 1911, 112.2 feet (34.2 meters) northeast of end of cement cricket alley, 159.5 feet (48.6 meters) south of middle of gravel path, 191.4 feet (58.3 meters) south of palm tree, 183 feet (55.8 meters) southwest of large cotton tree, and north of path through center of parade grounds; marked by tent peg driven flush with ground. True bearings: lone palm tree, 22° 59'.4; south edge of cannon house, 41° 44'.4; northeast corner of barracks containing guard room, 56° 20'.4.

Moyamba, 1912.—About one-half mile (0.8 kilometer) from railway station, and about 200 yards (183 meters) from United Brethren mission, about 400 feet (122 meters) north from huts used as barracks by court messengers, 250 feet (76 meters) north-northeast from nearest native house, 100 feet (30.5 meters) from middle of road on south, 35.3 feet (10.76 meters) west of corner of Creole cemetery, 200 feet (61.0 meters) southwest of center of entrance to Creole cemetery, and 12 feet (3.7 meters) west of center of road; marked by tent peg driven flush with ground. True bearings: far end post of Creole cemetery fence, 173° 23'.9; cross on Catholic mission, 1 mile, 328° 08'.1.

TRIPOLITANIA.

Tajura, 1913.—On most westerly of row of four or five low sand hills, about 400 meters north of railroad station; and in line between two palm trees standing respectively 21.8 meters east and 20.9 meters west of station; marked by cross in top of limestone post 42 cm. long and 17 by 30 cm. on top, set with top projecting about 3 cm. above ground. True bearings: west side of upper part of stonework covering well, 163° 59'.2; northwest corner of railroad station, 354° 32'.6.

Tripoli, 1913.—The C. I. W. station of 1905 was not considered suitable for reoccupation and a new station was established in inclosure south of main building of orphanage, 27.5 meters south-southeast of southeast corner of a low stone building, 50.1 meters east and 41.0 meters west respectively from stone boundary walls, and 17.0 meters south-southeast, 7.8 meters southwest, 7.5 meters northwest, 8.1 meters northeast, and 14.2 meters east from palm trees; marked by stake driven flush with ground. True bearing: tip of minaret of Mosque Hamid Pasha Karamanli in Tripoli, 100° 30'.0.

TUNISIA.

Feriana, 1911.—About one-half kilometer south of railroad station, 128 paces southeast from southeast corner of Hotel Feriana, 132 paces southeast of southwest corner of hotel, and 11 meters northwest of bank of dry water course; marked by round wooden stake. True bearing: signal tower on fortress, 242° 14'.7.

Houmt-Souk, Jerba Island, 1911.—About one-half kilometer west of Douane or custom-house, 57.5 meters south-southwest from first steps of ancient tomb called Sidi Yusuf and now used as Arab dwelling-house, 77.5 meters east-southeast from gate entrance through mud wall into garden, 53.5 meters east of and 25 meters northwest of palm trees on roadside, marked by wooden peg driven flush with ground. True bearings: semaphore near Douane, 289° 58'.7, cross on dome of Greek priest's house, 302° 21'.3.

Metlaoui, 1911.—South of Metlaoui, near French Catholic cemetery, in middle of street which leads up from plain to cemetery, 64.5 meters north-northeast from entrance into cemetery; marked by round wooden stake.

AFRICA.

TUNISIA—*concluded.*

Sfax, 1911.—West of Sfax, on east side of cart road which runs along mud wall surmounted by cactus hedge and which joins main road to Gabes about 400 meters south of La Louise Oil and Soap Factory; near north corner of uncultivated field, 6.2 meters from ditch, 12 meters south of corner of mud wall surmounted by cactus hedge, 12.5 meters south-southeast from plum tree in east corner of adjoining cultivated field, and 8 meters from center of cart road where it crosses ruined mud wall which divides the cultivated and uncultivated fields; marked by tent peg driven flush with ground. True bearings: lightning rod on smokestack of La Louise Factory, 200° 13'.9; minaret of Palais de Justice in Tunis, 240° 25'.9.

Susa, 1911.—West of Susa, near ruins called Hagra Makluba, 15.8 meters northeast of lone olive tree in cultivated field, 23.2 meters south-southwest of olive tree at foot of terrace, and 53 meters west of masonry ruins northeast of coffee shop; marked by wooden peg driven flush with ground. True bearings: tower at west corner of second white house visible to northward, 178° 05'.1, cross on lighthouse in Susa, 297° 41'.7.

Tunis, 1911.—Southwest of Tunis, near shore of small lake on road to Sedjoumi, about 200 meters northeast from Sedjoumi school, in field belonging to M. Pacteau, and in range between lone palm tree and boundary stone marked "80;" 8.7 meters northeast of palm tree, 17.2 meters southwest of boundary stone, and 32.5 meters southeast of center of ditch on southeast side of road leading from main Sedjoumi road towards lake; marked by wooden peg driven flush with ground. True bearings: tall chimney stack, 205° 56'.8; minaret of mosque, 235° 08'.1.

ASIA.

CHINA

Anking, Anhwei, 1911.—In northeast corner of the walled city, on football field of boys' school of American Episcopal Church Mission; 37.3 meters south of bottom step of lowest series of steps leading up terrace to school, and 16.86 meters west of large lone tree on field; marked by cross cut in top of brick sunk two inches (5 cm.) below ground.

Canton, 3, Kwangtung, 1911.—The C. I. W. station of 1908 was reoccupied. It is 21.04 feet (6.41 meters) east of northeast corner of boundary stone No. 017 of college property, 37.42 feet (11.41 meters) southeast of northeast corner of boundary stone No. 016, and 62.75 feet (19.13 meters) southwest of corner of boundary stone No. 015; marked by copper tack in teakwood peg driven flush with ground, and is in line No. 2 to Flowery Pagoda. True bearings: Flowery Pagoda, 128° 59'.2; southeast corner of East Hall, 54° 04'.6.

Chushan, Kwangtung, 1911.—About 10 miles (16 kilometers) northeast of Tungking, near outer end of long narrow sandbar across inlet south of Chushan village. True bearing: peak of gable roof at southeastern end of most prominent and most westerly building in Chushan, 152° 05'.8.

Hongkong Observatory, Hongkong, 1911.—The north and south observatory piers in observing hut and an outside station to south in line with piers. The latter (*B*) is 47.0 feet (14.33 meters) from south pier (*A'*) and 55.38 feet (16.88 meters) from north pier (*A*). These are same stations used in 1906, 1907, and 1908. The observatory is on hill nearly in center of Kowloon, which is on mainland just across bay from Hongkong.

ASIA.

CHINA—*continued.*

Ho Quan, Kiangsu, 1911.—See Linkiang.

Hwaiyuan An, Anhwei, 1911.—In yard south of boys' school of American Presbyterian Mission, 19.37 meters from southwest corner, in line with west edge of school building, 33.92 meters from southeast corner, and 9.90 meters from fence to south; marked by cross cut in top of granite block sunk 8 cm. below the ground. True bearings: second granite stone above water table at southwest corner of building, 206° 39′.9, second granite stone above water table at southeast corner of building, 261° 54′.5.

Kanchow Ki, Kiangsi, 1911.—On grounds of China Inland Mission in southeast part of city; in line between two posts of tennis court, 92.5 cm. from east post and 31.67 meters from south side of church building measured at right angles from east edge of east window. True bearing: northwest corner of residence, 152° 37′.2.

Kaokaitseu, Yunnan, 1911.—On southern slope of small hill southwest of railroad depot, 150 meters west-southwest of railroad coolies' quarters, in line with south end of quarters and just east of footpath. True bearing: east corner of main part of depot, just below eaves, 192° 04′.2.

Kianfu, Kiangsi, 1911.—On right bank of Kan River, about 1 mile (1.6 kilometers) above city, about three-fourths mile (1.2 kilometers) below Likin customs depot, and somewhat below prominent hill on opposite side of river, in small level tract between grave mounds that lie on higher ground to north, east, and south, top of bank about 8 meters high being about 3 meters to west; marked by cross cut in top of roughly rectangular piece of sandstone sunk flush with ground. True bearings: vertical diameter of dilapidated pagoda 141° 59′.9, roof ornament over east gable of Catholic church across river, 157° 20′.2.

Kiukiang, Kiangsi, 1911.—The station of 1907 in Victoria Park was not available. A new station was established on campus of William Nast College (Methodist mission) which is near south gate of city, at about middle portion of south wall; near southeast corner of football field, 24.6 meters east of center of large tree that stands on south side of ball field, 24.38 meters from more southern of east pair of goal posts, and 22.5 meters from center of pine tree that stands near southwest corner of lawn in front of residence just east of ball field; marked by cross cut in top of stone about 20 by 15 cm. sunk 6 cm. below ground. True bearings: tip of cupola on college chapel at west end of ball field, 90° 03′.5, southwest corner of stone ledge at southwest corner of main school building at level of first floor, 304° 56′.3; center of V-shaped cut in mountain seen just to west of faculty house with round pillars, 345° 28′.1.

Kuling, Kiangsi, 1911.—Within estate on children's playgrounds back of church, 30.90 meters from northwest post of pavilion in southeast corner of playgrounds, in line with east side of church, and 8.04 meters from low stone wall that bounds playgrounds on northeast side; marked by cross cut in top of stone buried 3 inches (8 cm.) below ground. True bearing: northeast corner of church, just under sloping roof coping, 42° 42′.8.

Linkiang (Ho Quan), Kiangsi, 1911.—Six feet (2 meters) from edge of left bank of Kan River, 200 paces south of its junction with the Zin, about 5 miles (8 kilometers) from city of Linkiang, and across the Zin from small village Ho Quan.

Lukiapang, Kiangsu, 1911.—Observations were made at three points D_a, D_b, and F, during intercomparison of instruments at the Lukiapang Observatory. D_a is magnetometer pier of absolute house. D_b is dip circle pier, 1 meter north of the earth-inductor pier in absolute house. F is outside absolute house on "Edmunds pillar," about 18 meters southwest of magnetometer pier.

Mengtsz, Yunnan, 1911.—Midway of slope which rises to west of the railroad station.

Namyung, Kwangtung, 1911.—On premises of German (Berlin) mission in the southeastern part of city, and just to northeast of the south gate, near which is "Bridge of Boats," south of Mission House, west of pond, on high ground near southwest corner of yard, 35 feet (10.7 meters) and 50 feet (15.2 meters) respectively from mud walls to west and south.

Nanchang, Kiangsi, 1911.—The C. I. W. station of 1908 was reoccupied. On grounds of Methodist mission, between three mission residences and river, and west of most southern of residences; 13 paces from river wall, measured from point 39 paces northwest of first angle; marked by cross cut in top of granite slab 11 by 3 inches (28 by 8 cm.) projecting about 7 inches (18 cm.) above ground. Southwest corner of the Charles residence is in true bearing 281° 28′.5.

Pakhoi, Kwangtung, 1911.—On grounds of Church Missionary Society, south of residence at present occupied by Dr. Neville Bradley, on plot between two tennis courts, 14.70 meters from west post of eastern court, 11.25 meters from east post of western court, and 14.01 meters from garden wall on south. True bearings: outer or north edge of west end of French Sisters' house, 215° 40′.2; nearest corner of Dr. Bradley's house, just above water table, 145° 22′.4.

Posi, Yunnan, 1911.—In field about 400 meters west of point on railroad about 400 meters north of railroad station. True bearing: east edge of west chimney of railway employee's residence, 246° 01′.2.

Shiuchow, Kwangtung, 1911.—On prominent bluff on right bank of river, below city, within grounds of Wesleyan mission, 24.55 meters south of southwest corner of two-story residence occupied by Mr. Ellison, in line with west side of residence, and 16.82 meters north of east post of gate. True bearings: southwest corner of Mr. Ellison's house, 163° 04′.8; tip of roof on tea-house in mountain gap across river, 251° 49′.7.

Soochow, Kiangsu, 1911.—The station of 1907 could not be recovered, owing to grading that had been done. The new station is on athletic field south of main building of Soochow University, exactly in line between northwest corner of eastern dormitory and southeast corner of Lynchburg Building, 109.5 feet (33.38 meters) from former and 126.7 feet (38.62 meters) from latter, 205.8 feet (62.73 meters) from southwest corner of main building, and 197.5 feet (60.20 meters) from southwest corner of porch of main building; marked by cross cut in top of stone slab sunk 3 inches (8 cm.) below ground. True bearings: southwest corner of main building at second course of bricks above water table, 160° 50′.4; southeast corner of main building just below eaves, 195° 54′.0.

Tatung, Anhwei, 1911.—On east bank of Yangtse River near northern entrance to eastern channel, about 3 miles (5 kilometers) north of city of Tatung and on third hill north of solitary temple which stands about opposite steamer offices on Tatung Island, about midway of southeast slope of hill. True bearing: west edge of most westerly window on north side of temple, 350° 32′.8.

ASIA.

CHINA—*concluded.*

Wongkong, Kiangsi, 1911.—About 17 miles (27 kilometers) below Kingtehchen, on Peh Ho or North River, which enters Payang Lake at or near Jaochowfu; on right bank of river about 300 paces below village landing, on level part of high bank in front of what appears to be most southerly house of village.

Wuhu, Anhwei, 1911.—The station of 1907 could not be occupied on account of high water. The new station is in cemetery on southeastern slope of hill east of hospital of American Methodist mission, about 300 meters east of former station and nearly due north of small house occupied by head Chinese physician, and 35 paces north of wire fence; marked by cross in top of large irregular stone set so as to project slightly above ground. True bearings edge of stack on electric light plant, 324° 21′.6, vertical center of cross on front of Catholic church, 346° 41′.2.

Yingtak, Kwangtung, 1911.—On tennis court in yard of most easterly residence of Baptist mission (residence occupied in 1911 by Mr Buckner), in line beween two net posts of court, 3.31 meters west of east post and about 38 paces from northwest corner of Mr. Buckner's residence, marked by cross cut in top of brick and buried flush with ground. True bearings: west edge of chimney on outbuilding in Mr. Buckner's yard, 11° 12′.0; pile of brick on mountain peak called Nam Shan, 12° 54′.1.

Yunnanfu, Yunnan, 1911.—In flower gardens owned by British consulate, between north gate and military camp, near northeast corner of grass plot which forms northeast corner of gardens, at a point 5.75 meters from northwest cedar hedge, 9 25 meters from northeast cedar hedge, and about 44.5 meters from center of small hexagonal summer-house; marked by a 4-cm. teakwood peg driven flush with ground. True bearings: edge of most easterly corner of military building across plain, 179° 15′.8; vertical diameter of tip ornament on summer-house, 314° 27′.0.

INDIA

Alibag, Bombay Presidency, 1911.—At magnetic observatory at Alibag about 17 miles (27 kilometers) from Bombay; three piers were occupied: stone pier, designated *L*, the only pier on the first observing floor of absolute house; stone pier, designated *U*, and wooden pier, designated U_s, both on second observing floor of absolute house, *U* being middle one and U_s being most southerly one of three piers set in north-and-south line.

Dehra Dun, 1911 —On central pier of south absolute house of magnetic observatory.

Karachi, Bombay Presidency, 1911.—South of Karachi, on east side of road from Karachi to Clifton, at edge of sand dunes, 325 paces southeast of 2 5-kilometer stone, and 310 and 360 paces respectively from lamp posts south and north of 2.5-kilometer stone; about 300 yards (274 meters) north of this point there is a public fountain where road divides; marked by wooden peg driven flush with ground. True bearings: lighthouse, 61° 15′; weathercock tower on Frere Hall in Karachi, 169° 37′.4.

INDO-CHINA.

Angkor-Vat, Cambodia, 1912.—On east side of road and 23 meters north of point which is 21 meters east of northeast corner of veranda of visitors' bungalow. True bearings: tip of central tower of temple, 258° 12′.4; roof-peak ornament at north end of small building at southeast corner of outer wall of temple group, 261° 07′.7.

ASIA.

INDO-CHINA—*continued.*

Banlacheng, Laos, 1911.—Near very small village, about midway between Tchépone and Heoun Hin, on north or right bank of Li Bang Hien, on slope between river and edge of jungle, and 15 paces east of village landing.

Bassac, Laos, 1912 —Two points, designated *A* and *B*, were occupied; *A* for declination and *B* for inclination. *A* is in middle of road that serves as principal street of village, a short distance due west of main village landing. *B* is at center of yard east of road, about 23 meters from declination station

Donsa, Laos, 1912 —On left bank of Mekong River, opposite Donsa Rapids, about 100 meters upstream from usual stopping place of steam launch

Haiphong Observatory, Tonkin, 1911 —See description of Phu Lien, Tonkin.

Hanoi, Tonkin, 1911.—In large vacant tract in section known as the Citadelle, between arsenal and botanical gardens and Le Residence, on square bounded on east by Avenue Victor Hugo, and on south by Avenue Général Bichot, 13 paces west of west side of old well curb in northeast corner of lot, 12 paces south and 16 paces southwest respectively from two large trees. The statue La France stands near northwest corner of lot. True bearings: more northerly of two ornaments on gateway of botanical gardens, 73° 07′.4; lightning rod on Intendance Militaire des Troupes Coloniales at southeast corner of intersection of Boulevard Carnot and Avenue Victor Hugo, 223° 50′.8

Hongchong, Cambodia, 1912 —On small sandy beach of cove just south of village. Inclination observed at secondary station about 60 meters south of main station.

Hué, Annam, 1911.—In small public park on river bank in French settlement, between river and junction of Rue Jules Ferry and Rue Rivière; near center of western grass plot, in line between centers of two circular flower beds, and distant 13 90 meters, 14 20 meters, and 14.15 meters respectively from trees at northwest, northeast and southwest corners of grass plot; marked by hardwood peg driven flush with ground True bearings: north edge of first pier at south end of railroad bridge, 69° 16′ 7; east edge of rampart around citadel flagpole across river, 109° 20′.6; top of clock tower near native market, in line with north pier of foot-bridge, 193° 00.′8

Kratié, Cambodia, 1912.—Two stations, designated *A* and *B*, were occupied. *A* is in yard back of administrative bureau, in line with third post of east veranda and northern extension of road leading from house of Commissionnaire Adjoint. *B* is on east edge of extensive sandbar on right side of river opposite Messageries Fluviales steamer landing True bearing tip of ornament on roof of steamship office, 250° 34′.5.

Langson, Tonkin, 1911.—Near west end of Avenue de la Follye des Joux, near east end of soldiers' football field, in line between north posts of east and west pairs of goal posts, 8.62 meters and 11.78 meters respectively from north and south posts of eastern pair. True bearings: outer edge of artillery barracks, at northwest corner, 31° 43′.2; vertical diameter of tip ornament on native temple near west end of field, 94° 23′.0.

Laobao, Laos, 1911 —About in center of large open area north of prison palisade and east of road that runs from prison entrance to river. True bearing. geodetic signal on mountain, 22° 32′ 2.

Laokai, Tonkin, 1911.—On right bank of Red River, on sandbar in middle of first bend of river below town.

ASIA.

INDO-CHINA—*continued.*

Pakhinboun, Laos, 1912.—Nearly in front of Government Bureau, between the vegetable gardens and left bank of river, 10 meters from edge of bank and 58 4 meters west of large tree with vertical row of spikes for climbing; marked by wooden stake set so as to project 7 cm. above ground

Paksane, Laos, 1912—About 200 meters below launch landing on Mekong River.

Paksé, Laos, 1912—Two stations, designated *A* and *B*, were established *A* is on sloping bank of Mekong River, about 200 meters downstream from regular steamer landing. True bearing: red concrete channel mark in river, 301° 40′.6. *B* is near edge of top of higher bank, a few meters northwest of *A*, in line with prolongation southward of street running from Mekong River past "Résidence" of Commissionnaire, and 10 meters south of large lone tree that stands at intersection of this street with road running parallel to smaller river

Phantiet, Cochin China, 1912.—In vacant lot east of hotel, in east angle formed by river road and road to railroad station, in line of east side of, and distant 16 7 meters from, a rectangular concrete well curb of more westerly of two wells, and 35 paces from river road Inclination was observed at secondary station about 40 paces west of main station.

Phu Lien, Tonkin, 1911.—On the grounds of Haiphong Observatory, on north slope of Observatory Hill, in line between main observatory and equatorial dome, in midst of level terrace designated by director of observatory as proposed site of his magnetic house; marked by round teakwood peg with countersunk center driven flush with ground. True bearings: middle one of three vertical edges of low fort building on hill, 51° 37′ 4; cross on top of Catholic church among some trees in plain, 15 kilometers, 169° 05′.2.

Pnompenh, Cambodia, 1912.—On left bank of river, a short distance below point opposite Grand Hotel, on grassy bank in front of native houses, about 3 meters northwest of slanting post projecting about 2 meters out of ground in front of native temple. True bearing: base of cross on prominent church in northern part of city, 128° 05′.0.

Quangtri, Annam, 1911.—On right bank of river and south of market place, in vacant lot about 45 meters square belonging to temple, 22 7 meters from tree at northwest corner of lot, and 15.2 meters east of next tree south along river road. True bearings: west edge of last steel upright on more western of two railroad bridges, 40° 39′ 1; tip of most western of small steeples on south side of mortuary memorial building, 158° 10′.3.

Saigon, Cochin China, 1912.—Northwest of city, in open country used as native burial place, 97 paces northwest of Rue Haute, which connects Saigon and Cholon, 19 7 meters northwest of concrete well curb, and 6.6 meters southeast of and in line with east edge of concrete grave which is 17.3 meters east of path to military barracks of native troops.

Savannakhet, Laos, 1912—Near south end of settlement, on narrow strip of land between river and road, 23.7 meters upstream from most southerly lamp post; marked by hardwood post 7 by 14 cm set so as to project 11 cm out of ground True bearing: peak of roof of Siamese temple, 79° 35′.0. A second hardwood post of same size, and with brass screw in top, was set to mark true meridian, 120.57 meters due north of station.

ASIA.

INDO-CHINA—*concluded.*

Stungtreng, Cambodia, 1912—On left bank of Mekong River, about 50 meters east of steps at boat landing

Tchépone, Laos, 1911.—In yard of French "Délegation," near southwest corner of bamboo fence, 13 meters from south side and 7 meters from west side; marked by hardwood peg projecting about 5 cm. above ground. True bearing· outer edge of square pillar at southeast corner of Délegation residence, at level of veranda floor, 287° 25′.3.

Tourane, Annam, 1911.—On beach east of harbor, opposite Hotel Tourane, at point about 205 paces north of telegraph line crossing harbor, and about 2 meters south of center of solitary low bush; marked by long peg driven nearly flush with ground. True bearings: base of steeple ornament on church across the harbor, 116° 11′.7; flagpole on the Résidence, at roof, 104° 13′ 4.

Vientiane, Laos, 1912—On west end of extensive sandbar in front of settlement

Vinh, Annam, 1911.—Near southeast corner of open plot in northwest quarter of garden of residence of inspector of civil service, 13 paces west of west side of main road, and 24 paces north of north side of road. True bearings: outer edge of northwest corner of outbuilding west of residence at height of instrument, 37° 16′.7, small conical pile or peak on top of larger mountain in distance, 138° 34′.3.

Yenbay, Tonkin, 1911.—On right bank of Red River, in sandy delta of stream which enters river a short distance to west; opposite Hotel de la Gare, which is in east end of French settlement on left bank of river True bearing: iron ornament on ridge of roof at west end of long barracks across river, 116° 22′.5.

SIAM.

Ayuthia, 1912.—In rice fields east of railroad station, about 200 meters east of railroad track. True bearing· tip of slender pagoda seen between railroad station and large ruined pagoda, 248° 32′.4.

Bangkok, 1912.—In oval of racecourse of Royal Sports Club, on northern outskirts of city, in line with north side of club-house, 196 paces east of inner end of canal bridge, and 93 paces west of inner side of canal, measurements being in line of north side of club-house. True bearings· vertical diameter of roof ornament at northeast corner of club-house, 100° 49′ 6; vertical diameter of spherical part of tip on tower seen between buildings of military training school, 189° 01′.6.

Huahin, 1912.—On beach in front of rest houses managed by railroad, 75 paces east of more northern one of two, and approximately in line with its north side.

Korat, 1912—In grounds in front of King's bungalow, in range with two poles that stand in north-south axis of grounds, 27.45 meters south of more southerly pole. True bearing: tip of ornament on peak of roof on front of long government building, 25° 46′.2

Lopburi, 1912.—Two stations, designated *A* and *B*, were occupied *A* is in open space between east outer wall of palace grounds and ruins of ancient treasury, on south side of path leading to palace gate, 22.20 meters north of brick wall of ancient treasury, 28.30 meters east of old brick outer wall of palace grounds, and 28 70 meters south of wooden post standing at northwest corner of intersection of main east-and-west path with path leading to travelers' bungalow True bearing. east edge of veranda post at southeast corner of bungalow, at level of porch railing, 196° 18′.4. *B* is

ASIA.

SIAM—*concluded.*

Lopburi, 1912—continued.
in southeast quarter of garden inclosure south of palace grounds, 13 meters south of east and west path, 7 meters east of north and south path, and about 145 meters southwest of *A*. True bearing: southeast corner of wall inclosing palace grounds, at level of wall coping, 201° 52′ 4.

Mehphuak, 1912 —In grounds of King's pavilion or reception bungalow, 17.26 meters northeast of northeast corner of King's bungalow, 16 04 meters south of southeast corner of retainers' bungalow, and 13 70 meters northwest of northwest corner of open dining pavilion.

Paknampoh, 1912.—On north bank of the Menam in front of Government Bureau, 12 meters south of tall wooden lamp post that stands just west of landing steps True bearing: flagpole on south bank of river, 283° 53′.5. Inclination observations were made at secondary station about 20 meters west of main station.

Pitsanuloke, 1912.—South of Royal bungalow, in yard of reception bungalow for King's retainers, south of brick walk, 21.7 meters southeast of gatepost on road near river, 29 9 meters northwest of southwest corner of retainers' bungalow, and 16 9 meters northwest of large tree. True bearing: tip of roof on gateway on west side of river, 106° 22′.5.

TURKISH EMPIRE

Aden, Arabia, 1911.—The station of 1909 on the crescent-shaped space called the "Crescent," containing bronze statue of Queen Victoria, was closely reoccupied; it is 9.6 meters west of middle point of bottom step of monument, 10.6 meters west-southwest of northwest corner of bottom step of monument, and 11 0 meters west-northwest of southwest corner of bottom step of monument; marked by wooden peg driven flush with ground. True bearings: pole on top of clock tower, 105° 58′.7; flagpole on Shum Shum signal station, 296° 56′.3.

Amara, Bagdad, 1911.—In continuation of most southerly street of town, which runs off to east from Tigris River into plain and passes between gardens surrounded by high brick walls on north side of street, and cultivated land surrounded on three sides by mud walls on south side of street, 49 paces east of northeast corner of wall surrounding cultivated land, 97 paces east of southeast corner of brick wall around gardens, and 120 paces southeast of entrance to gardens; marked by wooden peg driven flush with ground True bearings: flagpole, 127° 31′.8, minaret to northward of town, 174° 53′.7.

Anah, Bagdad, 1911.—On extreme eastern end of Sheikh Island, in Euphrates River, opposite police station and khan; 12.2 meters west of double willow tree, 18.0 meters southeast of most easterly of two date palms, and 18 meters east of large, stubby, gnarled tree; marked by wooden peg driven flush with ground. True bearing: vertical projection on northwest corner of police station, 16° 16′.3

Basra, Basra, 1911.—The station of 1909 was reoccupied within 1 meter. It is about one-fourth mile (0 4 kilometer) northwest of MacAndrews & Forbes Company's factory, in open space on northwest side of irrigating ditch, and separated from small native village by mud wall; 22 7 meters northeast of ruined mud hut, 40.7 meters east of corner of mud walls, 13 meters southeast of entrance through wall to village, 28 7 meters southwest from corner formed by mud wall and reed

ASIA.

TURKISH EMPIRE—*concluded.*

Basra, Basra, 1911—continued.
hut, and 23.1 meters west-southwest from end tree of row of date palms growing along irrigation ditch; marked by wooden peg

Hillah (Babylon), Bagdad, 1911 —On east bank of what is said to be bed of old Euphrates River but is now a canal flowing in a southerly direction through town, crossed by pontoon bridge; about one-third mile (0.5 kilometer) south of pontoon bridge, and in range between street leading into town and brick house on west bank of canal; 64 paces west-northwest of irrigation ditch leading from canal to water hoist to southeast, 48 3 meters northwest of south corner of that part of mud wall which lies between water hoist and street leading into town, 33.8 meters west of west corner of same wall, and 10 meters northeast of circular excavation in old bed of Euphrates, marked by wooden peg driven flush with ground True bearings: dome of Ziared, 2° 43′.8, minaret, 152° 59′ 4

Hodeida, Arabia, 1911.—On plain west of Hodeida, about 50 paces from beach, 200 and 188 paces west-northwest and northwest respectively from north and west corners of old fort, and 187 paces west-northwest from southwest end of tomb; marked by wooden stake driven flush with ground. True bearings: minaret, 267° 24′.6, minaret, 290° 35′.6.

Jidda, Arabia, 1911 —Southwest of Jidda, on small, low sandy island built on one of the reefs and called "Jezirat el Mifsaka" on British Admiralty charts; near "observation spot" for latitude and longitude marked in British Admiralty chart, being 25 paces east of high-water line and 107 paces south of high-water line; marked by wooden stake driven flush with ground. True bearings. minaret in western part of Jidda, 213° 28′ 6; minaret in southern part of Jidda, 227° 22′.4.

Muscat, Arabia, 1911.—Several miles west of Muscat, in small triangular valley west of Mutiah; 250 yards (229 meters) west of stone wall, 44.0 meters northeast of lone date palm, and approximately north 44.4 and 45.0 meters respectively from northwest and northeast corners of square stone building said to be used for religious purposes, the plain west of town and station is mainly used as a cemetery. True bearings: east corner of white stone building, 91° 09′.5; flagpole on stone tower (at crosstree), 292° 12′.9

AUSTRALASIA.

AUSTRALIA

Adavale, Queensland, 1913 —Near center of reserve bounded by Creek, Klugh, Shepherd, and Cudmore streets, 367.5 feet (112 02 meters) from survey post at north corner of reserve; marked by hardwood peg sunk just below ground True bearings: survey post at south corner of reserve, 350 feet (107 meters), 13° 18′ 3, survey post at west corner of reserve, 350 feet (107 meters), 67° 01′ 0; left gable end of police station, 400 feet (122 meters), 152° 51′ 0; survey post at north corner of reserve, 197° 01′.2; survey post at east corner of reserve, 370 feet (113 meters), 249° 34′ 2

Adelaide (Botanical Park), South Australia, 1911 —In Botanical Park, about 280 yards (265 meters) from Botanical Gardens, about 220 feet (67 meters) east from top of river bank, 117 feet (35.7 meters) from Victoria Drive, 867 feet (264 3 meters) from iron gates on opposite side of road from park gates, 38 feet (11.6

AUSTRALASIA.

AUSTRALIA—*continued.*

Adelaide (Botanical Park), South Australia, 1911—cont meters) from path to northwest, 35 feet (10 7 meters) from path to southwest, and 256 feet (78 0 meters) from big blue-gum tree to southwest.

Adelaide (South Park), South Australia, 1911.—In center of South Park, in range between Flinders Column on Mount Lofty and point on west boundary of park about 1.25 chains (25 meters) south of building line at northeast corner of King William Street and South Terrace; 45 feet (13.7 meters) from largest tree in grove to northwest. True bearings: spire of church near corner of park on King William Street, 300 yards (274 meters), 117° 45′.0, flagpole on post office tower, two-thirds mile (1.1 kilometers), 161° 17′ 0; flagpole on brick building, 221° 15′.7; Flinders Column on Mount Lofty, very distant, 293° 19′.5.

Albany, West Australia, 1912—In park lands reserve, 68.5 feet (20.88 meters) west of Moir Street, at Middleton Bay, on top of low ridge which runs parallel to road; marked by jarrah peg sunk just below ground. True bearings: bottom of flagstaff by large house across lake, 137° 36′.3; survey post *R 1299* at bend of road, distant 218 feet (66 5 meters), 215° 00′ 6; Breaksea Island lighthouse, 290° 47′.2; lowest visible point of signal post on brow of hill, 259° 49′ 4

Albany Island, Queensland, 1912.—Near beach at Port Albany, on small sandy knoll 30 feet (9 1 meters) west of center of small creek bed at Port Albany, 330 feet (100 6 meters) southeast of east corner of galvanized-iron shed; marked by square block of volcanic tufa projecting about 2 feet (0 61 meter) above ground and marked on top with triangle and hole in center. True bearings: right edge of Somerset station house, 1 mile (1.6 kilometers), 35° 50′ 6; edge of rocks above high water at Osnaburg, 1 25 miles (2 kilometers), 113° 49′.4; north corner of galvanized-iron house, 340 feet (103.6 meters), 140° 55′ 8.

Alberton, Victoria, 1913.—In public building reserve, on north bank of Albert River, 63 5 feet (19.35 meters) and 121.8 feet (37.13 meters) respectively from southeast and northeast corners of original courthouse site, 30 yards (27 meters) from bank of river, 38 yards (35 meters) from fence along Johnson Street, and 20 yards (18 meters) east of east line of courthouse site; marked by wood stake driven flush with ground. True bearings: bottom of southeast corner of fence of original courthouse site, 55° 03′ 7; center of top of right cross on gable of Anglican church, one-eighth mile (200 meters), 83° 19′ 9; bottom of northeast corner of fence of original courthouse site, 138° 55′.7; bottom of ornament over entrance of school, 159° 54′.3; center of right ornament over front of Victoria Hotel, three-fourths mile (1.2 kilometers), 169° 34′.5; top of spike over center of railway signal, 1 mile (1 6 kilometers), 176° 22′.7.

Albury, New South Wales, 1911—In Botanical Gardens on open green with few trees, lying between Dean Street and bowling green, 70 feet (21.3 meters) from row of trees south of path parallel to Dean Street, 62 feet (18 9 meters) and 78 feet (23.8 meters) respectively from nearest points of paths to northwest and southeast, and 236 feet (71.9 meters) from left gate-post of gate leading into bowling green; marked by wooden peg True bearings: bottom of flagstaff near bowling green, 230 feet (70 meters), 30° 58′ 7, lamp post on street corner opposite Dean Street gate, 264° 27′.4; near corner of right chimney of cottage across road from gardens directly in range with statue erected by Alderman Schmidt, 296° 05′ 9.

AUSTRALASIA.

AUSTRALIA—*continued.*

Alexandria, Northern Territory, 1913—On open ground north of station house, and south of Playford River, 273 feet (83 2 meters) from northwest corner of fence inclosing station house, and 290.5 feet (88 54 meters) from northeast corner of same fence; marked by small stake sunk just below surface. True bearings: northwest corner of fence, 4° 46′ 3; northeast corner of station fence, 321° 06′.7; left gable end of station house, 350 feet (107 meters), 347° 35′.0.

Alice Springs, Northern Territory, 1912.—On open flat in front of telegraph station, near telegraph line, 449.5 feet (137.01 meters) from northwest corner of officers' quarters; marked by wooden peg sunk just below surface. True bearings: Alice Springs trigonometric station, 207° 22′ 5; northwest corner of telegraph officers' quarters, 308° 47′ 4; bottom of pole carrying wind vane, about 450 feet (137 meters) distant, 319° 33′.9. Declination observations were also made at a secondary station about 300 feet (91 meters) from main station in direction of officers' quarters.

Alice Well, Northern Territory, 1912.—On camel pad from Alice Well to Francis Well, about 8.5 miles (14 kilometers) from former.

Anthony Lagoon, Northern Territory, 1913.—On open ground northwest of police station, 244.5 feet (74 52 meters) from northwest corner post of fence inclosing police station, and 284.5 feet (86 72 meters) from southwest corner post of same fence; marked by small stake sunk just beneath surface. True bearings: left end of Brunette out-station, one-half mile (0.8 kilometer), 98° 26′.2; northwest corner post of fence, 298° 46′.7; left gable end of police station, 290 feet (88 meters), 302° 44′ 9; southwest corner post of police station fence, 316° 51′.6.

Ararat, Victoria, 1911.—Near center of recreation ground of asylum and east of concrete cricket pitch, 39.5 feet (12.0 meters) from north end of pitch and 67 feet (20.4 meters) from south end. Azimuth observations were made at a point 71 feet (21.6 meters) distant in direction of railway crossing post used as azimuth mark, and 38 feet (11.6 meters) from south end of cricket pitch. True bearings from azimuth station: white railway crossing post, 18° 46′ 8; top of cover over water tank, 300 feet (91 meters), 39° 06′; flagpole on tower of fire-brigade station in town, 79° 47′ 6; flagpole on asylum tower, 1,200 feet (366 meters), 245° 51′.1.

Arltunga, Northern Territory, 1912.—On flat in gully above government battery, 221 feet (67 4 meters) from center of front of galvanized-iron cottage, 356 feet (108.5 meters) from northwest corner of battery, 460 feet (140.2 meters) from pole carrying wind vane on post office, and about 200 feet (61 meters) nearly due west of ruined cottage; marked by wooden peg sunk just below surface. True bearings: right edge of battery building, 10° 07′.6; pole carrying wind vane on post office, 33° 41′ 8; center of bull's eye of target, 335° 30′.2. Declination observations were also made at a secondary station about 38 paces from main station in direction of bull's eye of target

Armidale, New South Wales, 1913.—Inside the track of racecourse reserve bounded by Dumaresq, Douglas, and Barney streets and 2½ paces north of center line of Rusden Street extended into reserve, 421 feet (128.3 meters) from boundary fence at right edge of Rusden Street gate, 550 feet (168 meters) from near corner of sports grounds, marked by hardwood peg sunk just beneath surface of ground. True bearings: spike over belfry of school, one-fourth mile (0 4 kilometer), 23° 19′.4; top of spire of cathedral, 1 mile (1 6 kilo-

AUSTRALASIA

AUSTRALIA—*continued.*

Armidale, New South Wales, 1913—continued. meters), 97° 31′.8, near corner of sports grounds fence, 208° 39′.5; top of tower over pavilion at show grounds, one-half mile (0.8 kilometer), 224° 29′.8.

Attack Creek, Northern Territory, 1912.—About 30 yards (27 meters) east of telegraph line and opposite third pole from Attack Creek on north side.

Bairnsdale, Victoria, 1913.—In water reserve north of Mitchell River, on a ridge 50 feet (15.2 meters) high, between Bruthern Road and back water of Mitchell River. True bearings: top left edge of brick chimney stack of creamery on far bank of river, one-fourth mile (0.4 kilometer), 7° 41′.8, center gable, facing river, of Jackson's tannery, one-eighth mile (0.2 kilometer), 34° 48′.3; extreme top right edge of left chimney of School of Mines, on far side of river, one-half mile (0.8 kilometer), 74° 25′.6; center of high steeple over courthouse on far side of river, three-fourths mile (1.2 kilometers), 82° 03′.7, center of top of cross on right gable end of Anglican church on far side of river, three-fourths mile (1.2 kilometers), 88° 33′.7. Neumayer's station was on south side of Mitchell River, near School of Mines, about one-half mile (0.8 kilometer) distant.

Ballarat, Victoria, 1913.—In Victoria Park, near tree nursery next to curator's house, 335 feet (102.1 meters) and 485 feet (147.8 meters) respectively from southeast and southwest corners of nursery fence, and 53 yards (48.5 meters) west-northwest from carriage drive measured from point on drive 420 yards (384 meters) from the gate at corner of Sturt Street and Victoria Parade; marked by wooden peg sunk flush with ground. True bearings: bottom of southwest corner of nursery fence, 151° 30′.6; center of ornament over gable of lunatic asylum, three-fourths mile (1.2 kilometers), 156° 43′.2; southeast corner of nursery fence, 195° 46′.8; center of right cross over gable of Loret's Abbey, one-third mile (0.5 kilometer), 197° 02′.6; center of ornament over rotunda in Victoria Park, one-tenth mile (161 meters), 230° 48′.2; bottom of weather vane over high tower, 1 mile (1.6 kilometers), 278° 24′.6.

Barrow Creek, Northern Territory, 1912.—On flat about 20 yards (18 meters) east of telegraph line, 281 feet (85.6 meters) from southeast corner of telegraph station, 141 feet (43.0 meters) from southeast corner of meat house, and 164.2 feet (50.05 meters) southeast of nearest corner of wall around grave. True bearings: nearest corner of stone wall around grave, 122° 03′.6; stone cairn on hill on west side of Barrow Creek, 1,300 feet (396 meters), 157° 18′.3, southeast corner of telegraph station at bottom, 178° 31′.8, southwest corner of stone cottage at bottom, 250 feet (76.2 meters), 209° 53′.9, stone cairn on north peak of hill behind station, 1,000 feet (305 meters), 220° 27′.4; stone cairn on south peak of hill behind station, 500 feet (152 meters), 242° 15′.4.

Batchelor, Northern Territory, 1912.—At government experimental farm at Batchelor, on ridge just south of men's quarters, about 100 yards (91 meters) along ridge from manager's temporary quarters; marked by wooden peg sunk flush with ground and covered with small cairn of stones.

Bayswater, Western Australia, 1912.—Three stations, designated *A*, *B*, and *C*, were occupied at German variation of latitude observatory at Bayswater, a suburb of Perth. *A* is 92 feet (28.0 meters) northeast of northeast corner of observatory, and 13 feet (4.0 meters) from large tree. True bearings nearest corner of observatory, 53° 23′; *C*, 43° 17′.8. *B* is center of masonry pier in center of observatory. True bearing: flagstaff on distant large house, 358° 22′.8. *C* is 21.6 feet (6.58 meters) south of *B*, in line to flagstaff on large house.

Bedourie, Queensland, 1913.—In southwest corner of police reserve at corner of Herbert and Timor Streets, 62.5 feet (19.05 meters) northeast of southwest survey peg of police reserve; marked by peg sunk just beneath surface. True bearings: southwest survey peg of police reserve, 46° 36′.3; northwest survey peg of reserve, 250 feet (76 meters), 174° 27′.4, near gable end of police station, 260 feet (79 meters), 242° 45′.3.

Beech Forest, Victoria, 1912.—On top of ridge on which township is situated, south of McInnes Street and opposite second bend from Gardner Street, 312 feet (95.1 meters) from northwest corner post of fenced paddock, 176 feet (53.6 meters) from fence post at second bend in McInnes Street on north side, 53 feet (16.2 meters) from center of old well, and about 80 paces north of railway. True bearings: right edge of roof ridge of cottage in valley, one-half mile (0.8 kilometer), 7° 42′.4; center of front of Commercial Bank, one-third mile (0.5 kilometer), 269° 18′.2, top of right ventilator of church, 287° 34′.3; gable end of southernmost building on skyline of rise across valley, 3 miles (5 kilometers), 321° 08′.4.

Beltana, South Australia, 1911.—About center of ridge which lies between railroad and township, 90 yards (82 meters) north of road which crosses ridge and about one-third mile (0.5 kilometer) northwest of township. The ridge is bare except for a few scattered bushes. True bearings: semaphore signal post, 23° 24′.4; gable of railway station, 81° 32′.7; trigonometric station on hill, 83° 21′.9; edge of mountain, 20 miles (32 kilometers), 263° 56′.6; Royal Victorian Hotel, 331° 58′.8. Dip observations were also made at secondary station 69.5 feet (21.18 meters) south by west of main station.

Bendigo, Victoria, 1913.—In gravel reserve about 1.2 miles (2 kilometers) from Bendigo town hall, on eastern edge of high ridge, about 300 yards (274 meters) north of railway line and about 20 yards (18 meters) south-southeast of post marking miner's claim. True bearings top of pole in magazine inclosure, 350 yards (320 meters), 20° 45′.9, bottom of flagstaff on tower of Seamark Hotel, 1.2 miles (2 kilometers), 50° 25′.3; center of face of post-office clock, 1.2 miles (2 kilometers), 51° 29′.6.

Blood's Creek, South Australia, 1912.—About 3 miles (5 kilometers) towards Oodnadatta from Blood's Creek Store, and about 60 paces east of Oodnadatta road. True bearing: trigonometric station on Mount Hammersley, distant 6 miles (10 kilometers), 264° 25′.0.

Boorabbin, Western Australia, 1912.—On north side of railway, 227 feet (69.2 meters) from point in line with north edge of platform on south side of track, and about 300 feet northeast of corner of station building; marked by jarrah peg sunk beneath surface. True bearings: northeast corner of station building, 24° 30′.0, left edge of railway tank, 53° 07′.5.

Boorthanna, South Australia, 1911.—On west side of railway, 301 feet (91.7 meters) from siding, 353 feet (107.6 meters) from northwest corner of nearest ganger's cottage, and 122 feet (37.2 meters) from northwest corner of concrete foundation that once supported water tank; marked by jarrah peg driven in ground. True bearings: left-hand post supporting station name, 320 feet (97.5 meters), 213° 02′.3; northeast corner of nearest ganger's cottage, 304° 55′.2.

AUSTRALASIA.

AUSTRALIA—*continued*

Border Town, South Australia, 1911.—On common at back of Woolshed Inn and near racetrack, on flat ground near top of rise, about 500 feet (152 meters) south of railway. True bearings: ornament on front gable of house, one-fourth mile (0.4 kilometer), 13° 15′ front gable end of institute, one-half mile (0.8 kilometer), 347° 18′.7. Three large gum trees stand 121 feet (36 9 meters) southeast, 236 feet (71.9 meters) south, and 145 feet (44 2 meters) southwest, respectively.

Boulia, Queensland, 1913.—In southeast corner of temporary reserve at northwest corner of Pituri and Boulia streets, 83 feet (25.3 meters) northwest of southeast survey peg of reserve; marked by gum peg sunk just below surface True bearings: left spike on roof of Shire Hall, 1,200 feet (366 meters), 94° 23′ 9; front spike of Rabbit Board office, 650 feet (198 meters), 123° 23′.7; northwest corner of Herbert and Boulia streets, 460 feet (140 meters), 179° 56′.7; southeast survey peg of temporary reserve, 83 feet (25 3 meters), 314° 22′.1.

Bourke, New South Wales, 1913.—In water-works reserve, on bank of Darling River, between Cullie and Cobar streets, 50 feet (15 2 meters) from southeast fence and 87.5 feet (26 67 meters) from east corner at Cullie and Wartumurtie streets. True bearings: left edge of chimney of engineer's cottage, 700 feet (213 meters), 36° 12′.1; leftmost support of water tower, center at bottom, 230 feet (70 meters), 67° 35′.7; center of chimney of pump-house, 300 feet (91 meters), 101° 17′.1, east corner of reserve, 253° 37′. Auxiliary station 1 was 40 paces, 60°.2 west of south from main station.

Bowen, Queensland, 1913.—Near George Street gate of fence inclosing Botanical Gardens reserve, 195.5 feet (59 59 meters) from Hay Street boundary fence; marked by peg sunk just below ground True bearings: right post of near gate of reserve, 100 feet (30 5 meters), 45° 26′ 0.; south corner of George and Hay streets, 200 feet (61 meters), 46° 10′.0.; spike on rear of roof of Bank of New South Wales, 0.3 mile (0.5 kilometer), 55° 11′ 8; right end of roof of North Australia Hotel, 0.4 mile (0.6 kilometer), 75° 16′.0.

Box Tree Flat, South Australia, 1912.—About 7 miles (11 kilometers) beyond the Wire Creek Bore, on road from Oodnadatta to Macumba and Dalhousie cattle stations, and 80 paces west of track, on level sandy plain on south side of sparse patch of box trees. True bearing: top of highest peak to eastward, 251° 31′.1.

Bridgetown, West Australia, 1912.—In recreation ground reserve near corner of Gifford Road and Steere Street on east side of town (town lots 86 and 87), 195.5 feet (59 59 meters) from northwest corner and 92 5 feet (28.19 meters) from west fence; marked by jarrah peg True bearings: northwest corner of grounds, 150° 17′.6; northeast corner of grounds, 241° 19′.8.

Brisbane, Queensland, 1913.—In Victoria Park, on slope below Children's Hospital, 206 5 feet (62 94 meters) from corner of Children's Hospital fence at intersection of streets, and 233 5 feet (71.17 meters) from right corner of Children's Hospital fence, marked by sandstone post 6 by 6 by 15 inches (15 by 15 by 38 cm) sunk 1 inch (3 cm.) below ground and lettered on top "CIW 1913." True bearings: right cross on convent, one-half mile (0 8 kilometer), 6° 17′.1; center of spike on building at Brisbane Grammar School, three-fourths mile (1.2 kilometers), 37° 23′.1; Children's Hospital fence at street corner, 155° 01′ 7; left ventilator on Children's Hospital, 350 feet (107 meters), 179° 21′.1; corner of fence bounding Children's Hospital, 228° 27′ 8; center of top of rear tower of museum, one-fourth mile (0 4 kilometer), 294° 42′.1; center of top of right front tower of museum, one-fourth mile (0.4 kilometer), 301° 50′.5; top of St. Paul's Church steeple, three-fourths mile (1.2 kilometers), 350° 58′.5.

Brisbane University, Queensland, 1913.—On northwest corner of tennis lawn of university staff, 23.5 feet (7.16 meters) from domain fence, and 70 feet (21.3 meters) from water tap near fence and opposite center of tennis court. True bearing: spike on top of large building across river, one-half mile (0.8 kilometer), 336° 38′.7.

Broken Hill, New South Wales, 1911.—Near center of football oval west of town and about 1 mile (1 6 kilometers) from post office, and one-half mile (0.8 kilometer) north of Silvertown Tramway's main station; 320 feet (97 5 meters) east of pavilion; 303 feet (92 4 meters), 214 feet (65.2 meters), 307 feet (93 6 meters), and 157 feet (47.9 meters) respectively northeast, southeast, southwest, and northwest from cycle track encircling football oval; marked by jarrah peg 2 by 3 by 20 inches (5 by 8 by 51 cm) driven a little below surface True bearings: southeast corner of railway water tank, distant 0.8 kilometer, 34° 26′.7; semaphore signal post, 900 meters, 54° 01′.2; gable and flagpole of pavilion, distant 293 meters, 96° 40′.5.

Broken Hill Reservoir, New South Wales, 1911.—On hill about 180 yards (165 meters) southeast from lower end of reservoir and about 600 yards (549 meters) south-southwest of pump-house; the reservoir is about 10 miles (16 kilometers) east-northeast of Broken Hill. True bearing: west gable of pump-house, 200° 42′.1

Brunette Downs, Northern Territory, 1913.—On open ground northwest of station buildings and north of cattle yards, 186 feet (56.7 meters) from corner of yards, and 354.5 feet (108.05 meters) from northwest corner of yards, marked by gum peg sunk just beneath surface. True bearings: northeast corner of cattle yards, 10° 40′ 5; northwest corner of cattle yards, 58° 24′.6; near gable end of station house, 700 feet (213 meters), 299° 37′ 0.

Bunbury, West Australia, 1912.—Near top of rise in unused Roman Catholic cemetery reserve lying between Prinsep and Wellington streets, west of Roman Catholic convent and church, east of public cemetery, and 190 feet (57.9 meters) and 125 feet (38 1 meters) respectively from southwest and northwest corners of reserve. True bearings: right cross on roof of shelter in public cemetery, 82° 01′.2; top of lighthouse, 192° 43′ 6; beacon on end of breakwater, 202° 10′ 9; right edge of higher railway tank, 228° 07′.9; cross on steeple of Congregational church, 275° 56′.4; center of weather gage on hill, 346° 49′.8.

Burketown, Queensland, 1912 —About three-fourths mile (1 2 kilometers) up Albert River southeast of Burketown, 30 feet (9.1 meters) from bank of river, northwest of group of three graves within inclosures, northwest corners of which, in order from one nearest river, are distant 50.5 feet (15.4 meters), 57 feet (17 4 meters), and 50.2 feet (15.3 meters) respectively; marked by wooden peg. True bearings: top of south gable end of Commercial Hotel, one-half mile (0.8 kilometer), 125° 47′.7; top of south gable end of galvanized-iron building on river bank, east of Commercial Hotel, north side of street, one-half mile (0.8 kilometer), 140° 09′.2; northwest corner of fence around grave nearest river (approximately), 296° 53′.

AUSTRALASIA

AUSTRALIA—*continued.*

Burra, South Australia, 1911—In part of Burra known as Kooringa, in football ground owned by the corporation, 100 feet (30 5 meters) from northeast wall, 106 feet (32 3 meters) from southeast wall, and 59.5 feet (18 1 meters) from fence surrounding football oval. True bearings: spire on church on opposite hillside, about one-fourth mile (0 4 kilometer), 54° 02′.6; ornament on left end of lower school building, 71° 02′ 8, center of right-hand post of main gate, 275 feet (83 8 meters), 90° 30′ 8; center of near face of chimney of old smelter, 108° 11′ 3; gable edge of large shed in football ground, 149° 04′.1

Burt Well, Northern Territory, 1912—On large level plain east of telegraph station on Burt Creek, 995 feet (303 3 meters) south-southeast from southeast corner of stone coping around well. True bearing: center of left pulley wheel over well, 168° 20′.5

Byron Bay, New South Wales, 1913.—In public recreation ground east of town, 99 5 feet (30 33 meters) from west fence, and 181.5 feet (55.32 meters) from southwest corner survey post. True bearings: center of near end of church on skyline, 1,000 feet (305 meters), 44° 16′.2; southwest corner survey post, 51° 26′.0; spike on front of porch of church, 900 feet (274 meters), 90° 41′.1; flagstaff over Great Northern Hotel, one-third mile (0.5 kilometer), 134° 26′.6; northwest corner post of grounds, 600 feet (183 meters), 189° 20′ 5; center of top of lighthouse, one-half mile (0.8 kilometer), 244° 43′.9.

Cairns, Queensland, 1912—On outskirts of town, on lot No. 167 reserved for recreation ground, at corner of Aplin and Severn streets; marked by peg sunk just below ground. True bearing: center of survey peg at north corner of lot, 253 feet (77.1 meters), 162° 20′.0

Camooweal, Queensland, 1913.—In northwest corner of pound reserve at corner of Barklay and Morrison streets, 217 feet (66.1 meters) from northwest corner of reserve, and 196 feet (59 7 meters) from northwest corner of impounding yards, marked by small gidya stake sunk just below surface. True bearings. northwest corner of impounding yards, 29° 08′; southeast survey peg of post-office reserve, 220 feet (68 meters), 59° 28′.7; center of tower on roof of post office, 500 feet (152 meters), 113° 14′.8; center of tower on roof of police station, 850 feet (259 meters), 150° 41′ 8; northwest survey peg of pound reserve, 160° 49′.6; northeast survey peg of pound reserve, 300 feet (91 meters), 233° 24′ 4.

Canobie, Queensland, 1913—About 300 yards (274 meters) northeast of Canobie station house. True bearings: left edge of station house at bottom, 900 feet (274 meters), 34° 09′.1; near gable end of blacksmith shop, 750 feet (229 meters), 57° 53′ 7

Cardwell, Queensland, 1912.—On public esplanade along seashore, about one-half mile (0.8 kilometer) from post office, 100 yards (91 meters) northwest of intersection of Victoria Street and prolongation of jetty, 256.5 feet (78.2 meters) from strainer post at north corner of boundary fence surrounding house facing Victoria Street; marked by wooden peg sunk flush with ground. True bearings: center of top of lamp over shed on jetty, 254° 12′ 0; center of north gable end of galvanized-iron house on Victoria Street, 450 feet (137 meters), 328° 44′ 0; center of top of strainer post, 332° 12′ 8.

Casterton, Victoria, 1912—In paddock owned by Mr Grant, 256 2 feet (76.1 meters) southeast of strainer post at northwest corner of paddock, and 259 5 feet (79.1 meters) east-northeast from strainer post at corner of fence where Casterton road forks to Sandford and Hamilton; marked by peg sunk just below surface of ground. True bearings: center of ornament on left gable of grandstand in show grounds, 42° 31′.5; cross on gable facing southwest on Roman Catholic convent, one-half mile (0 8 kilometer), 67° 41′.6; Sugarloaf Hill trigonometric station, 5 miles (8 kilometers), 313° 10′.3. Declination observations were also made at secondary station 55 yards (50 meters) northeast of main station and in range with main station and cross on gable of Catholic convent.

Ceduna, South Australia, 1911.—On small rise about 400 yards (366 meters) from hotel, about one-fourth mile (0 4 kilometer) north of movable target of rifle range. True bearings: inner end of pier at Denial Bay, 5 miles (8 kilometers), 109° 30′.2; center of mooring post at outer end of Murat Bay jetty, one-third mile (0.5 kilometer), 132° 57′.8; ornament on gable on front of Murat Bay Hotel, 177° 31′ 1, small iron cross on front of Methodist church one-third mile (0 5 kilometer), 189° 48′.4

Charleville, Queensland, 1913—In public park reserve between Edward and Galatea streets, 186 feet (56 7 meters), from survey peg at east corner of reserve, and 232 feet (70.7 meters) from north corner of reserve, marked by hardwood peg sunk just below ground True bearings: southwest corner of reserve, 1,000 feet (305 meters), 46° 11′ 5; northwest corner of reserve, 400 feet (122 meters), 81° 23′.8, north corner of reserve, 177° 04′.2; east corner of reserve, 281° 17′.0.

Charlotte Waters, Northern Territory, 1912.—On open space behind stockyard of telegraph station, 40 feet (12.2 meters) from southeast corner of stockyard, 380 5 feet (115.97 meters) from southeast corner of blacksmith shop, 325.5 feet (99 21 meters) from northeast corner of meat shed, and 324 feet (98.8 meters) from north corner of powder magazine, marked by wooden peg, witnessed by bottle and small stake about 6 feet (1.8 meters) north and south respectively, all placed just below surface of ground True bearings: near corner of meat shed, 36° 46′ 3, left edge blacksmith shop, at bottom, 63° 06′.5; left edge of chimney of blacksmith shop, at bottom, 65° 01′.2; near gable end of iron shed at McKenna's, one-half mile (0.8 kilometer), 141° 57′.5; near corner of powder magazine, 338° 12′.3.

Charlton, Victoria, 1913—In southern portion of public recreation reserve, 40 yards (37 meters) northwest of north bank of Avoca River, southeast of southeast boundary fence of cricket ground, and 68 yards (62 meters) southeast of post at southwest corner of fence around cricket ground; marked by wood stake set flush with ground. True bearings: top right edge of railway water tower, three-eighths mile (0 6 kilometer), 26° 54′ 3; top right edge of brick chimney stack of Kendall's flour mill, five-eighths mile (1 kilometer), 47° 52′.4, top of right gatepost of recreation reserve, 600 yards (549 meters), 86° 22′.4; center of top of post at southwest corner of fence around cricket ground, 97° 50′ 2; center of middle circular opening in brick water tower, three-eighths mile (0.6 kilometer), 101° 43′.6; bottom right edge of cricket house, 90 yards (82 meters), 202° 58′.0; bottom right edge of post at southeast corner of cricket ground, 200 yards (183 meters), 216° 27′.9 Neumayer's station was about 1 mile north of this station, on opposite bank of river.

AUSTRALASIA.

AUSTRALIA—*continued.*

Charters Towers, Queensland, 1913.—Near center of ring in showgrounds reserve 382.5 feet (116 58 meters) from northwest corner of reserve True bearings: bottom of left post supporting roof of grandstand 250 feet (76 meters) 77° 41′.7; northwest corner of reserve 136° 31′ 2; top of belfry of church one-half mile (0.8 kilometer) 281° 50′ 2; center of top of tower of post office one-half mile (0 8 kilometer) 309° 56′.2; center of top of large chimney, on hilltop, 1 mile (1.6 kilometers), 351° 44′ 8.

Chillagoe, Queensland, 1912 —On large open field which lies in south angle between Atherton and Cathedral streets on outskirts of town, 163.5 feet (49 8 meters) south-southwest from small clump of rocks, marked by peg sunk just below ground. True bearings: center of highest point on rocky bluff, three-eighths mile (0.6 kilometer), 1° 24′.7; center of survey peg at corner of Atherton and Cathedral streets, one-eighth mile (0.2 kilometer), 180° 54′.2; right edge at bottom of Hessian house, one-fourth mile (0 4 kilometer), 249° 38′ 8; center of highest point of large rocky mound, five-eighths mile (1 kilometer), 293° 21′ 2; bottom of flagstaff on rocky mound, three-eighths mile (0 6 kilometer), 334° 33′ 6

Chinchilla, Queensland, 1913 —In a reserve across Charley's Creek from town, in line with south side of Chinchilla Street, 210.5 feet (64 16 meters) from survey peg marked "XIII, 4," 381 3 feet (116.22 meters) from nearest fence corner on Chinchilla Street, and 710 feet (216 meters) from near corner of Chinchilla Street and lane which is continuation of Helena Street; marked by hardwood peg sunk just below ground. True bearings: center of tower over Royal Hotel, 0.2 mile (0.3 kilometer), 240° 31′.9, near corner of Club Hotel, one-fourth mile (0 4 kilometer), 279° 37′.4; south side of Chinchilla Street, 302° 12′ 5; cross on near end of Anglican church, 0 2 mile (0 3 kilometer), 356° 00′.6.

Clermont, Queensland, 1913 —In recreation reserve behind town hall, in east half of reserve, 205.5 feet (62.64 meters) from point where line of east side of Karmoo Street cuts reserve fence True bearings· spike on rotunda in showground, one-fourth mile (0 4 kilometer), 181° 05′ 8; northwest corner of East and Drummond streets, 560 feet (171 meters), 243° 48′.6; point on reserve fence where line of east side of Karmoo Street intersects, 65° 11′ 4

Cloncurry, Queensland, 1913 —On southeast end of town reserve, north of cemetery reserve and east of Sheaffe Street, 396 feet (120 7 meters) from northwest corner of cemetery reserve, marked by small stake sunk just beneath surface. True bearings: northwest corner of cemetery reserve, 29° 12′ 7, left gable end of engine shed, one-half mile (0 8 kilometer), 298° 30′.5; northeast corner of cemetery reserve, 530 feet (162 meters), 315° 18′ 3; left gable end of railway station, three-fourths mile (1 2 kilometers), 320° 21′.2; center of cross on Roman Catholic church, 450 yards (411 meters), 336° 51′.6.

Cobar, New South Wales, 1913 —In showground reserve, on west outskirts of town, on north side of Wilcannia Road, 159 feet (48 5 meters) from fence to southeast, and 281 feet (85 6 meters) from southernmost corner post; marked by hardwood peg sunk just below surface of ground True bearings· fence post at south corner of grounds, 34° 49′.0; fence post at southwest corner of grounds, one-fourth mile (0 4 kilometer), 110° 34′ 7, fence post at northeast corner of grounds, one-fourth mile (0 4 kilometer), 194° 22′ 6; center of bottom of tallest chimney of Great Cobar Mine, 1 mile (1.6 kilometers), 290° 51′.9, center of cross on rear end of roof of Roman Catholic church, one-half mile (0.8 kilometer), 297° 51′.4; Cobar trigonometric station, 5.2 miles (8 kilometers) 324° 44′.5.

Cockburn, South Australia, 1911 —On small hillock south of railway line on open ground belonging to Crown and used for football field, about 1,300 feet (396 meters) south-southeast of the institute, 437 feet (133 2 meters) from fence inclosing railway yard, and 220 feet (67 1 meters) from nearest south goal post, marked by red-gum peg 3 by 2 inches (8 by 5 cm); sunk flush with ground. True bearings: chimney of pump-house at dam 0.8 kilometer, 48° 53′.2; semaphore signal post, 550 meters, 104° 44′.6; west gable of English church, 460 meters, 200° 40′.1; south gable of institute, 216° 34′.7; east edge of railway water tank, 350 meters, 224° 08′.7; east gable of engine shed, 460 meters, 243° 42′.7.

Coen, Queensland, 1913.—On school reserve, southeast of school building, east of small track and west of small mound and about 107 feet (33 meters) from blazed bloodwood tree; marked by ironwood stake sunk below ground. True bearings: right gable end of Boyd's cottage 1,300 feet (396 meters), 91° 05′.4; left gable end of police cottage, 1,300 feet (396 meters), 102° 43′.4; near gable end of school shed, 550 feet (168 meters), 139° 21′.6; blazed bloodwood tree, 151° 56′.

Colona, South Australia, 1911.—In slight depression 129 paces southwest of south corner of station house and 61 paces northeast of nearest telegraph pole True bearings: pipe of windmill one-half mile (0 8 kilometer), 188° 09′ 3; left edge of station house, at bottom, 219° 57′.9

Condobolin, New South Wales, 1913.—Near Condobolin astronomical station, in trigonometrical reserve on top of hill north of town. True bearings: center of bottom of low spire of Roman Catholic church, 1 mile (1.6 kilometers), 39° 01′.6; center of trigonometric pole, 35.5 feet (10.82 meters), 236° 38′.

Connell's Creek, Northern Territory, 1912.—Near small landing used by a buffalo hunter named Connell, on creek about 20 miles east of Adelaide River and about one-half mile (0.8 kilometer) from mouth of creek, at edge of open plain beyond mangroves which fringe river for about 100 yards (91 meters) from the landing; marked by cedar peg True bearing: pandanus palm tree, one-half mile (0.8 kilometer), 100° 34′.6

Cooktown, Queensland, 1912, 1913.—Station of 1913 is closely that of 1912; on open grassy slope east of town between lines of Hogg and Howard streets, 44 feet (13 4 meters) from blazed milk tree, and 453 feet (138 1 meters) east-southeast from southeast corner fence post of house in block between Garden and Kimberley streets; marked by hardwood peg sunk just beneath ground. True bearing. center of right ventilator over State School three-eighths mile (0.6 kilometer), 152° 17′ 4.

Coolgardie, Western Australia, 1912.—In park lands on north side of town, in section bounded by Toorak, Moran, MacDonald, and Jobson streets, 429 feet (130 8 meters) from southwest corner, 258 feet (78.6 meters) from south fence, and 48 feet (14 6 meters) north-northeast of gum tree; marked by jarrah peg sunk beneath surface. True bearings· left gable end of Presybterian church, one-fourth mile (0.4 kilometer), 299° 30′.9; cross on right gable end of Catholic church, 330° 05′.6; center of cross of left gable of convent, 345° 26′.3.

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AUSTRALIA—*continued.*

Cooma, New South Wales, 1913.—In Nijong reserve, inside fence marking running track, 228 feet (69 5 meters) and 418 5 feet (127 56 meters) respectively from southwest and southeast corners of reserve. True bearings. bottom of southwest corner fence post, 76° 27′.7, left end of railway freight shed, 280° 52′.5; left edge of jail wall, 600 feet (183 meters), 302° 22′.5; top of watch tower at corner of jail, 500 feet (152 meters), 312° 49′.7; top of right watch tower of jail, 600 feet (183 meters), 324° 54′.9.

Coonalpyn, South Australia, 1911.—On east side of railway line, about 300 feet (91 meters) from railway station, 172 feet (52 4 meters) from the gate in fence bounding railway reserve, 209 feet (63 7 meters) from front corner of store, and about 400 feet (122 meters) from southern semaphore and small white post carrying lamp. True bearings: southernmost semaphore, top of pole, 12° 25′.2; right edge of railway station, 132° 22′.2.

Coonamble, New South Wales. 1913.—In water reserve at northeast corner of Dubbo and Taloon streets, near Coonamble Creek, 81 feet (24.7 meters) west-southwest from astronomical trigonometric station, and 7 feet (2.1 meters) east of fence line on east side of Dubbo Street True bearings: center of spike projecting over water tower, one-half mile (0.8 kilometer), 5° 20′.1; northwest corner of intersection of Taloon and Dubbo streets, 300 feet (91 meters), 27° 10′ 1; center of astronomical trigonometric pole 255° 11′ 6.

Coward Springs, South Australia, 1911 —On south side of the railway, 369 feet (112.5 meters) from main track, 388 feet (118.3 meters) northwest of southwest corner of hotel, 366 feet (111.6 meters) from nearest corner of railway station, and 602 feet (183.5 meters) from bore of artesian well; marked by jarrah peg. True bearings: gable of engine running shed, 550 feet (167.6 meters), 162° 10′.2; pipe of artesian bore, 243° 08′.6; near gable end of station house, 247° 53′.3; top of semaphore pole, 1,200 feet (366 meters), 280° 51′.4; ornament on front gable of hotel, 395 feet (120.4 meters) 291° 19′.1.

Cowell, South Australia, 1911.—On football oval on showgrounds northwest of town and jetty, and about three-fourths mile (1.2 kilometers) from latter, approximately in center of oval, 216 feet (65.8 meters) west-northwest from gate; marked by jarrah peg 3 by 3 by 15 inches (8 by 8 by 38 cm.), sunk somewhat below surface of ground.

Crown Point, Northern Territory, 1912.—In Cunningham Gorge on Finke River, between Crown Hill and hill on opposite side, a little upstream from line joining the two hills.

Croydon, Queensland, 1912 —On unoccupied ground between hospital and race-course reserves, about three-fifths mile (1 kilometer) south of railway station; marked by spotted-gum peg sunk flush with ground True bearings: southeast corner of hospital fence, 342 feet (104.2 meters), 68° 09′ 7; ventilator on top of hospital, 108° 55′ 2, northeast corner hospital fence, 384 8 feet (117 28 meters), 149° 34′ 5; right edge of railway tank, 168° 43′.1; center of mine chimney, 210° 07′.4; flagstaff in front of school, 221° 48′.6; near corner of bottom of race-course grandstand, 516.5 feet (157 43 meters), 255° 49′ 1. Declination observations were also made at a secondary station, 100 paces in line toward flagstaff at schoolhouse.

Cundalabbie Tanks, South Australia, 1911.—In line with west edge of catchment shed which shelters tanks, 69 feet (21.0 meters) south of southwest corner.

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AUSTRALIA—*continued.*

Cunnamulla, Queensland, 1913 —In southwest corner of race-course reserve, 343.5 feet (104.70 meters) from southwest corner, marked by peg driven flush with ground. True bearings· southwest corner of reserve, 72° 44′.0; center of near cross on church, 1 3 miles (2 kilometers), 80° 59′.0; right gable end of F. Hobson & Co 's store, 1 mile (1 6 kilometers), 90° 38′.4; left end of tower on roof on Grayson's store, 1 mile (1 6 kilometers), 100° 37′.9; near gable end of railway shed, three-fourths mile (1.2 kilometers), 135° 26′ 8, northwest corner of race-course reserve, one-half mile (0 8 kilometer), 185° 37′.4; southeast corner of reserve, one-half mile (0.8 kilometer), 285° 45′ 0.

Currawilla, Queensland, 1913.—On flat in front of station, about 200 yards (183 meters) from protecting dam in front of it, and about 30 yards (27 meters) northeast of sandhill True bearings: junction of dam and sandhill, 200 yards (183 meters), 115°; center of left veranda post of new building at station, 700 feet (213 meters), 141° 55′.6.

Daly Waters, Northern Territory, 1912.—On open flat about 100 yards (91 meters) northwest of water hole in Daly Waters, about 5 miles (8 kilometers) south of telegraph station.

Dee Bridge, Tasmania, 1913.—North of stable belonging to Mr. Squires, 66 feet (20 1 meters) from northwest corner of stable, and 350 feet (107 meters) north of Mr. Squires's cottage True bearings. northwest corner of stable, 5° 22′ 5; left edge of rear chimney of Mr. Squires's cottage, 10° 06′.7; northeast corner of stable, 75 feet (22 9 meters), 338° 21′.4.

Deniliquin, 1913.—In public park south of Edward River, 110 feet (33 5 meters) southeast from northwest corner of fence around park, and 95 yards (87 meters) from west fence; marked by wooden stake set flush with ground. True bearings: top right edge of left gatepost in park fence, 100 yards (91 meters), 118° 25′.8; bottom left edge of northwest corner fence post, 134° 50′.6; bottom left edge of chimney stack of water works, one-eighth mile (0 2 kilometer), 221° 27′.2; bottom left edge of top left window of water tower, one-eighth mile (0.2 kilometer), 225° 45′.3.

Diamond Drill Tank, South Australia, 1911.—About 0.6 mile (1 kilometer) east of the tank and 218 5 feet (66 60 meters) southeast of eleventh telegraph pole counting eastward from tank. True bearings: eleventh telegraph pole, 143° 15′ 5; fifteenth telegraph pole, 241° 38′.7.

Dirranbandi, Queensland, 1913.—In stock route reserve, on south side of railway station, 788.5 feet (240.33 meters) from junction of fence around station master's house with that around station grounds. True bearings: spike over ventilator of station master's house, 800 feet (244 meters), 202° 35′.2; spike over ventilator of railway shed, 1,000 feet (305 meters), 225° 44′.6

Dubbo, New South Wales, 1913.—Two main stations, designated *A* and *B*, were occupied. *A* is near New South Wales astronomical station, on top of rise about 1.5 miles (2 kilometers) west of town, in paddock south of main road which crosses Macquarie River, and 129.5 feet (39.47 meters) from astronomical station. True bearings: astronomical station, 33° 50′.5; distant trigonometric station, 10 miles (16 kilometers), 248° 41′.9; top of spire of St. Andrews Presbyterian church, 2 miles (3 kilometers), 298° 01′ 0; inner corner of tower of brewery, 2 miles (3 kilometers), 326° 21′ 9. Auxiliary station 1 was 33 paces, 326° 4 west of south, from *A* and indicated very great disturbance. *B* is near northeast corner of park, 288.5 feet (87 93 meters)

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AUSTRALIA—*continued.*

Dubbo, New South Wales, 1913—continued.
from northeast corner, and 154 feet (46.9 meters) from east fence; marked by hardwood peg sunk just below surface of ground. True bearings: northeast corner post of park 221° 00'.4; center of top of chimney stack of Davie's joinery works, 700 feet (213 meters), 336° 03'.8.

East Maitland, New South Wales, 1913—In east half of large park on rise in southern part of town, south-southeast of south corner of William and Park streets, 397 feet (121.0 meters) from north corner survey post 226 feet (68 9 meters) from northwest fence; marked by wooden peg sunk just beneath surface of ground. True bearings: south corner fence post, 800 feet (244 meters), 8° 55'.7; north road corner at Rouse and William streets, 118° 46'.3; belfry of Anglican church, 500 feet (152 meters), 170° 33' 5, center of north corner survey post, 199° 45'.6, center of ornament on front of Wesleyan church, 1,000 feet (305 meters), 209° 32'.5; center of bottom of cross on far end of Catholic church, one-fourth mile (0 4 kilometer), 256° 07'.4.

Eastmere, Queensland, 1913.—On ground just outside station paddock, south of Eastmere station house, 243.5 feet (74 22 meters) from right edge of railing round grave True bearings: left bar of station kitchen window, 600 feet (183 meters), 161° 21' 8; near gable end of station house, 600 feet (183 meters), 166° 18'.0; right edge of grave railing, 291° 17'.5.

Echuca, Victoria, 1913.—In public park and recreation ground 272 feet (82 9 meters) from nearest corner of Hopwood's granite obelisk; marked by wooden peg driven flush with ground. True bearings: bottom left edge of fourth block from ground, granite pedestal of Hopwood's monument 97° 13'.9; center of first "O" in "Hopwood" on fourth block from ground, 97° 29' 8; top left edge of chimney of Rosel's cordial factory, one-eighth mile (0.2 kilometer), 311° 28'.3; center of left ornament on left gatepost of park, one-tenth mile (160 meters), 316° 40'.7; top of ornament on right side of Governor Lock's red-gum arch, 70 yards (64 meters), 334° 14'.1. Neumayer's station was approximately three-fourths mile northwest of this point

Eden, New South Wales, 1913—On open grass plot near north corner of Bramble and Imlay streets, and north of reserve containing the Lookout Point Lighthouse, 97 feet (29.6 meters) from fence post at west corner of reserve, and 148 feet (45.1 meters) from west corner of Imlay and Bramble streets. True bearings: west corner fence of lighthouse grounds, 21° 29'.2; middle gable of Boyd's Hotel across bay, 3 miles (5 kilometers), 41° 28'.4; bottom of flagstaff over Bank of New South Wales, one-half mile (0 8 kilometer), 149° 48' 6; right edge of chimney of Great Southern Hotel, one-half mile (0.8 kilometer), 153° 48' 7.

Edithburgh, South Australia, 1911.—In portion of park lands immediately west of township and about one-half mile (0 8 kilometer) from jetty, about 700 yards (640 meters) west-northwest of large stone house near jetty, 300 yards (274 meters) north-northwest of stone shop on corner of main street, 131 feet (39.9 meters) from York Town Road, and 332 feet (101.2 meters) from fence to east; marked by jarrah peg 2 by 3 by 20 inches (5 by 8 by 51 cm), set a little below surface. True bearings: chimney of chaff mill, 460 meters, 48° 42'.0; spire of Anglican church, 365 meters, 272° 18'.7; ornament on large stone house near jetty, 293° 52' 8

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AUSTRALIA—*continued.*

Elsey Creek, Northern Territory, 1912.—About 50 yards (46 meters) north of the creek and about 100 yards (91 meters) southwest of ruins of old Elsey Creek station

Emerald, Queensland, 1913.—In public park reserve containing race-course, 252 5 feet (76.96 meters) from southwest corner of reserve, marked by hardwood peg sunk just below ground True bearings: survey post at southwest corner of reserve, 51° 01'.6; survey post at street corner opposite southwest corner of reserve, 400 feet (122 meters), 59° 22'.6, left chimney on roof of hospital, 900 feet (274 meters), 141° 44'.6; south corner of reserve, 0.2 mile (0 3 kilometer), 309° 27'; right gable end of church, one-half mile (0.8 kilometer), 335° 24' 0

Eromanga, Queensland, 1913.—In reserve containing police station, 285 feet (86.9 meters) from survey peg at northwest corner, and 310 5 feet (94 64 meters) from survey peg at northeast corner; marked by peg sunk just below ground. True bearings: left end of roof of police station, 390 feet (119 meters), 21° 53' 3; near corner of left chimney of Royal Hotel, one-third mile (0.5 kilometer), 70° 33' 6; left edge of right chimney of Australian Hotel, one-third mile (0.5 kilometer), 85° 27'.3; survey post at northwest corner of police reserve, 157° 09'.4; survey post at northeast corner of reserve, 224° 09'.1; southeast survey peg of reserve, 450 feet (137 meters), 342° 22'.3.

Eucla, Western Australia, 1911.—On open ground east of settlement, 192 feet (58.5 meters) east of corner of fence opposite telegraph offices and quarters, 203 feet (61 9 meters) southeast of southeast corner of concert hall, and about one foot (0.3 meter) south of point in range with east and west fence. True bearings: wind vane on telegraph office, 108° 05'.8; bottom of flagpole on operators' quarters, 122° 51'.9; gable end of hall, 137° 47'.2.

Farina, South Australia, 1911.—Two stations, designated *A* and *B*, were occupied at this place. The main station, *A*, is west of town, on small knoll in northeast corner of police paddock, about 1 mile (1.6 kilometers) west of railway station, about 2,400 feet (732 meters) due west of Exchange Hotel, about 2,200 feet (671 meters) west-northwest of English church, 594 feet (181.1 meters) from east fence of paddock, and 637 feet (194.2 meters) from north fence; marked by jarrah peg set about 2 inches under ground. True bearings gable of pump-house, 230° 11'.0; west gable of public school, 279° 57'.0; west gable of English church, 288° 56'.4; west gable of red-roofed house, 1 mile (1.6 kilometers), 313° 13'.2. Dip observations were made at secondary station 120 feet (36 6 meters) from *A* in direction of west gate of English church. *B* is about one-half mile northeast of *A* and about 1,000 feet (305 meters) due north of Exchange Hotel. True bearings: semaphore signal post to southeast of railway station, three-fourths mile (1.2 kilometers), 326° 57'.9; west gable of public school, 31° 12'.5.

Flinders, South Australia, 1911.—On top of small bluff, the first northeast of town, about three-fourths mile (1.2 kilometers) from Mudge's Hotel and jetty, in center of bare spot where sand and limestone are exposed, 17 feet (5 2 meters) from edge of cliff; marked by peg driven in ground. True bearings: center of front face of church at top, 48° 14' 4; near corner of right chimney of Mudge's Hotel, 55° 58'.2; outer edge at bottom of shed on end of jetty, 81° 46'.0.

Forsayth, Queensland, 1912—On slight elevation in valley northwest of the township, between terminus of railway and schoolhouse, northeast of two high knobs at

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AUSTRALIA—*continued.*

Forsayth, Queensland, 1912—continued. west end of range of hills; marked by peg projecting slightly above ground. True bearings: center of left ventilator of school, 150° 28′.3; center of leftmost window of Forsayth Hotel, five-eighths mile (1 kilometer), 288° 28′.1; right gable end of hall at back of Goldfields Hotel, five-eighths mile (1 kilometer), 290° 35′.6

Frew's Ponds, Northern Territory, 1912.—About 1 mile (1.6 kilometers) along telegraph line beyond point where it enters bush on north side of Sturt's Plain, about 2 miles (3 kilometers) from Frew's Ponds and about 75 feet (23 meters) west of telegraph line.

Garden Island (Sydney Harbor), New South Wales, 1913.—On north end of Garden Island and north of tennis court at point occupied by H.M.S. *Fantome* in 1909; marked by point of arrow in top of concrete block lettered on top "Magnetic spot Obs. H.M.S. *Fantome* 1909." The same general locality was also occupied by the Sir J. C. Ross, Navara, and *Challenger* expeditions. True bearings: center of tank on top of Fort Denison, one-half mile (0.8 kilometer), 143° 08′.5; beacon on Cremone Point, three-fourths mile (1.2 kilometers), 198° 16′.6; beacon on Bradley's Head, 1 mile (1.6 kilometers), 251° 50′.3; tip of round tower on South Head, 3 miles (5 kilometers), 260° 26′.6; top of outer South Head lighthouse, 3 miles (5 kilometers), 264° 33′.0.

Gayndah, Queensland, 1913.—On point of land between Burnett River and creek east of town, in second section of land east of first bend in road east of river, 105 feet (32.0 meters) northeast of survey peg No. 6 at intersection of road and dividing line of two sections, marked by rough peg. True bearing: survey peg at corner of next section west, 54° 25′.

Geelong, Victoria, 1912.—In botanical gardens, about 108 feet (32.9 meters) and 268 feet (81.7 meters) respectively from northeast and northwest corners of the maze, marked by wooden peg sunk just below surface of ground. True bearings: ornament over right dormer window of curator's house, 55° 15′.4; center of easternmost of three chimneys of freezing-works across the bay, 153° 56′.4. Declination observations were also made at a secondary station 40 yards (37 meters) northeast of main station and in range with main station and ornament on curator's house.

Geraldton, Western Australia, 1912.—In park lands outside town boundary on north side of Eastern Road and opposite public cemetery reserve, 246.5 feet (75.13 meters) from post which marks beginning of slight bend to north in road, marked by jarrah peg. True bearings: survey peg marking bend in road, 20° 19′.0, Scott's Hill trigonometric station, 0.6 mile, (1.0 kilometer), 97° 32′.0; top of White Peak, 186° 48′.5.

Gilbert Creek, Northern Territory, 1912.—About 18 miles (29 kilometers) along road to north of Bonney Creek, 3 miles (5 kilometers) west of Gilbert, and about 50 yards (46 meters) west of telegraph line.

Gladstone, Queensland, 1913.—In recreation reserve, 490 feet (149 meters) from survey peg marking north corner of sports ground reserve, 146 feet (44.5 meters), from iron fence inclosing sports ground, marked by small peg sunk just below ground. True bearings: spike on near end of grandstand in sports ground, 600 feet (183 meters), 34° 15′.0; north corner survey peg of sports ground, 123° 33′.4; flagstaff on Blue Bell Hotel, two-thirds mile (1.1 kilometers), 168° 39′.0; near corner of tennis pavilion, 400 feet (122 meters), 236° 39′.1.

AUSTRALASIA.

AUSTRALIA—*continued.*

Goondiwindi, Queensland, 1913.—In northwest corner of race-course and show-ground reserve, 385 feet (117.3 meters) from northwest corner fence post; marked by hardwood peg sunk just below ground. True bearings: left ventilator of railway station, 0.4 mile (0.6 kilometer), 9° 49′.0; near gable end of station, 200 feet (61 meters), 17° 52′.4; northwest corner of reserve, 153° 50′.0; right gatepost at northeast corner of reserve, one-half mile (0.8 kilometer), 271° 13′.0; near gable end of grandstand, 356° 06′.5

Goulburn, New South Wales, 1913.—In northeast half of Victoria Park, near west corner, 141 feet (43.0 meters) from fence along Deccan Street, and 260 feet (79.2 meters) from nearest gatepost in Deccan Street fence. True bearings: left edge of chimney of bath keeper's house, 300 feet (91 meters), 36° 37′.3; near corner of left gatepost, at bottom, 82° 03′.5; top of church spire, three-fourths mile (1.2 kilometers), 279° 03′.6

Goyder Creek, Northern Territory, 1912.—About 1 mile (1.6 kilometers) beyond well at Goyder Creek, about 50 yards (46 meters) west of road to Alice Springs.

Hanson's Well, Northern Territory, 1912.—About 170 yards (155 meters) southwest of Hanson's Well. True bearing: right edge of support of windlass over well, 228° 50′.2.

Harden, New South Wales, 1913.—In Murrumburrah Park, near southwest corner, 239 feet (72.8 meters) from survey post at southwest corner, 102.5 feet (31.2 meters) from south boundary fence, and 37.5 feet (11.4 meters) from nearest gum tree. True bearings: southwest corner survey post, 84° 14′.0; spire of church across valley 1.2 miles (2 kilometers), 129° 15′.8; top of school belfry, one-fourth mile (0.4 kilometer), 157° 04′.2; right edge of O'Connel's Royal Hotel, one-half mile (0.8 kilometer), 179° 52′.4; left edge of railway tank, one-half mile (0.8 kilometer), 199° 06′.1; center of iron chimney of works near Rhoy, 257° 33′.8

Harvey's Return, South Australia, 1911.—Near west end of Kangaroo Island, on north coast between landing used for unloading stores for Cape Borda Lighthouse and top of ridge, 90 yards (82 meters) south from galvanized-iron shed, and same distance from head of cable tramway used for hauling up stores.

Hawker, South Australia, 1911.—On lower peak of Police Hill, about 0.8 kilometer due north of Hawker, in government paddock used as catchment for reservoir near railway station; marked by peg driven flush with ground and surrounded by cairn of stones 4 feet (1.2 meters) in diameter. True bearings: east gable of railway station, 800 meters, 12° 29′.1; northernmost point of prominent peak in gap, 10 kilometers, 24° 01′.5; semaphore signal post, 1.2 kilometers, 348° 41′.0, west chimney of Royal Hotel, 900 meters, 357° 18′.5.

Hay, New South Wales, 1913.—In reserve for public recreation, west of Pine Street, in portion north of Leonard Street, 159.5 feet (48.62 meters) north from fence inclosing sports oval, and 387 feet (118.0 meters) from point where this fence joins Pine Street fence. True bearings: center of bottom of left flagstaff over grandstand in oval, 800 feet (244 meters), 26° 18′.4; right edge of water tower, 1,000 feet (305 meters), 29° 45′.2; northwest corner of fence around oval, 800 feet (244 meters), 84° 56′.5; near end left gable of railway workshop, one-half mile (0.8 kilometer), 161° 11′.1; northeast corner of reserve, 800 feet (244 meters), 214° 56′.4; northeast corner of fence around oval, 302° 51′.6.

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AUSTRALIA—*continued.*

Hergott Springs, South Australia, 1911.—On open ground on south side of railway, 180.5 feet (55 0 meters) southeast of fence surrounding block containing Great Northern Hotel, 295 feet (89 9 meters) southwest from fence bounding railway property, 200 feet (61 meters) east of nearest corner of Wilson's butcher shop, and 4.5 feet (1.37 meters) nearer railway than is building line at rear of hotel block True bearings: gable of small white iron cottage, 14° 43′ 2, gable ornament on Wilson's butcher shop, 73° 43′.7; near corner Great Northern Hotel, 300 feet (91.4 meters), 157° 55′ 0; center of top of semaphore, 230 feet (70.1 meters), 213° 07′.2, near gable end of railway running shed, 330 feet (100.6 meters), 246° 17′ 6.

Hillston, New South Wales, 1913—In northwest corner of race-course reserve, 151 8 feet (46.27 meters) from northwest corner of reserve and 70 feet (21 3 meters) from west fence; marked by small white pine stake. True bearings: cross on front of Roman Catholic church, two-thirds mile (1 kilometer), 138° 46′.4, northwest corner survey peg, 160° 37′ 0; northeast corner fence post, one-half mile (0 8 kilometer), 270° 37′.3; spike on near gable end of small building in race-course grandstand inclosure, one-third mile (0 5 kilometer), 318° 37′.1.

Hobart, Tasmania, 1911.—The observations were made at three stations, designated *A*, *B*, and *C*, in government paddock north of Government House. *A* is 347 feet (105.8 meters) from left post of iron gate nearer Government House, 343 5 feet (104.70 meters) from right post of farther gate, and 177 5 feet (54.10 meters) north-northeast from southeast end of orchard wall True bearings: flagpole near gate of botanical gardens, 150 yards (137 meters), 74° 50′ 7; white monument in cemetery, 2 miles (3 kilometers), 155° 14′.4, flagpole on Government House, 150 yards (137 meters), 343° 26′.4 *B* and *C* are northeast of *A*, distant respectively 59 feet (18.0 meters) and 145 5 feet (44 35 meters), in line toward common azimuth mark, gable of house 2 miles distant across Derwent in true bearing 226° 11′ 3.

Hog Bay, South Australia, 1911.—On Kangaroo Island, on small grass-covered spit west of and between Christmas Cove and the sea, about one-half mile (0.8 kilometer) west of Hog Bay jetty and 20 yards (18 meters) from high-water line on either side; marked by piece of schist about 6 by 6 by 20 inches (15 by 15 by 51 cm.) set a little below surface of ground. True bearings: south gable of Anglican church, 180 meters, 33° 22′ 2; north gable of institute, 230 meters, 54° 14′.0, south gable of district council hall, 0.8 kilometer, 70° 32′.2; Flinders cairn, 2.5 kilometers, 92° 18′.8; wind vane on southeast gable of police station, 365 meters, 246° 34′ 0.

Horseshoe Bend, Northern Territory, 1912.—About 2.5 miles (4 kilometers) from Horseshoe Bend Hotel, about 100 yards (91 meters) from camel pad going to Alice Springs, about one-half mile (0 8 kilometer) along table-land from where it rises out of Finke River.

Horsham, Victoria, 1911.—In Botanical Garden Reserve, between band rotunda and Wimmera River, 130 feet (39.6 meters) from rotunda, 320 feet (97.5 meters) from fence along west side of continuation of Main Street where it meets river, and 803 feet (244.8 meters) from near corner of caretaker's cottage

Hughenden, Queensland, 1913.—In large water reserve on west bank of Flinders River, 209 5 feet (63.86 meters) east from railway siding, and 298 5 feet (90 98 meters) northwest of survey peg marked "R-R" at northwest corner of Uhr Street and unnamed street leading to

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AUSTRALIA—*continued.*

Hughenden, Queensland, 1913—continued
hospital. True bearings. spike on water tower, 0 8 mile (1.2 kilometers), 11° 25′ 0; bottom of smokestack of railway pumping station, 680 feet (207 meters), 298° 59′.4; center of survey peg "R-R," 300° 02′.4; Uhr Street corner across road from above, 460 feet (140 meters), 304° 49′.8; center of front of cross on Roman Catholic church, one-third mile (0 5 kilometer), 332° 45′ 8; southeast corner of Hardwicke Street and street leading to hospital, one-fourth mile (0 4 kilometer), 352° 35′.2.

Ivanhoe, New South Wales, 1913.—About one-half mile (0.8 kilometer) from township on road to Mossgiel, near first bend in telegraph line, and about 48 chains (1 kilometer) northwest from New South Wales Survey astronomical position True bearings. near gable end of pump-house at dam, 159° 32′.2; iron telegraph pole, 331 feet (100.9 meters), 263° 00′.6.

Jericho, Queensland, 1913—In stock and camping reserve, north of town, just beyond railway inclosure, 244 feet (74 4 meters) from near corner of railway inclosure, and 473 feet (144 2 meters) from Edison Street fence of railway inclosure True bearings. corner of railway inclosure at Edison Street crossing, 24° 16′.6; end of stock trucking race, 700 feet (213 meters), 245° 04′ 5; near corner of railway inclosure, 310° 51′.5; near end of railway station, 800 feet (244 meters), 325° 10′.5; near corner of Queen's Hotel, 1,000 feet (305 meters), 329° 51′ 2

Katanning, Western Australia, 1912—One-half mile (0.8 kilometer) northeast of railway station, in agricultural show-grounds (town lot 416), 150.5 feet (45 87 meters) from northeast corner survey post and 103 5 feet (31 55 meters) from east fence; marked by jarrah peg sunk just below ground True bearings: center of front of Railway Coffee Palace, 51° 28′.1; flagstaff on left tower of Katanning Hotel, 60° 41′.4; survey post at northeast corner of grounds, 268° 24′.3.

Katherine River, Northern Territory, 1912—In horse paddock of Katherine telegraph station, 451.5 feet (137 62 meters) northeast of east corner of masonry tower supporting telegraph wire, 438 feet (133 5 meters) south of left edge of wooden shed northwest of stockyard, and 98 feet (29 9 meters) north of gum tree; marked by wooden peg sunk just below surface True bearings: bottom of right iron pole on telegraph tower on near side of river, 60° 57′.5; bottom of right iron pole on telegraph tower on far side of river, 93° 56′.8, left edge of strainer corner post of stockyard, 196° 25′.5.

Kynuna, Queensland, 1913—On town reserve, 400 feet (122 meters) northeast of Roman Catholic church, and north of Mitchell's Selection, 126 feet (38.4 meters) and 200.5 feet (61.11 meters) respectively from north and east posts of selection; marked by small stake sunk 1 inch (3 cm) below ground True bearings: center of chimney of police station, 500 feet (152 meters), 1° 12′.7; north corner of Mitchell's Selection, 25° 12′ 0; right gable end of Roman Catholic church, 400 feet (122 meters), 27° 49′.2; right gable end of school, one-half mile (0 8 kilometer), 136° 52′.2; left gable end of hospital, 300 feet (91 meters), 146° 10′.3; right gable end of post office, 550 feet (168 meters), 321° 14′.7; east corner of selection, 200 5 feet (61.11 meters), 344° 56′.8.

Laura, Queensland, 1912.—Between bush and flat water-course on west side of railway, and 926 feet (282.2 meters) from northwest corner of railway station; marked by peg sunk just below ground. True bearings. right arm of "U" on station name board, 325°

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AUSTRALIA—*continued.*

Laura, Queensland, 1912—continued. 48'.0; nearest corner of railway station at bottom, 328° 41'.4; bottom right edge of railway station, 331° 04'.7; left gable end of hotel, 333° 09'.2; left gable end of freight shed, 336° 36'.0. Auxiliary declination observations were made at secondary station 80 paces from the main station in direction of right edge of railway depot.

Laverton, Western Australia, 1912.—On recreation ground on north side of town, 647 feet (197.2 meters) from southwest corner of grounds, 551 feet (167.9 meters) from south fence, and 94 feet (28.7 meters) from west goal post at south end of football oval; marked by jarrah peg sunk just below surface. True bearings: trigonometric station on Mount Crawford, 171° 20'.0, bottom of west goal post, 94 feet (28.7 meters), 240° 51'.4; left gable end of railway workshops, one-half mile (0.8 kilometer), 320° 49'.0.

Lawlers, Western Australia, 1912.—In recreation ground reserve, 82 feet (25.0 meters) from north fence and 112 feet (34.2 meters) from west fence; marked by short jarrah peg set flush with ground. True bearings: top of mine chimney visible on skyline, 254° 26'.9; right end of roof ridge Commercial Hotel, one-half mile (0.8 kilometer), 258° 26'.9. Declination observations were also made at secondary station 84 paces from main station in direction of top of mine chimney.

Leech's Billabong, Northern Territory, 1912.—About 100 yards (91 meters) northwest of billabong (slough), known also as Eastern Billabong.

Longford, Tasmania, 1913.—In recreation ground, near fence around sports oval, at station established by Magnetic Survey of Tasmania, 158.5 feet (48.31 meters) northwest from astronomical station which is marked by Muntz metal peg in top of concrete block 1 foot (30 cm.) square on top, set 6 inches (15 cm.) below ground. True bearings: astronomical station, 149° 06'; left edge of chimney of cottage, 800 feet (244 meters), 329° 05'.8.

Longreach, Queensland, 1913.—In recreation reserve, just north of railway and east of showgrounds, 123 feet (37.5 meters) from north corner of recreation reserve, and 619 feet (188.7 meters) from south corner; marked by hardwood peg sunk 1 inch (3 cm.) below ground. True bearings: flagstaff on front of Shire Hall, 0.2 mile (0.3 kilometer), 3° 47'.1, flagstaff on tower of Commercial Hotel, one-fourth mile (0.4 kilometer), 11° 22'.8; cross on tower of convent, one-third mile (0.5 kilometer), 32° 08'.6; west corner of recreation reserve, 450 feet (137 meters), 48° 05'.4; south corner of showgrounds, 0.1 mile (0.16 kilometer), 58° 07'.4; spike on near gable end of showground grandstand, 350 feet (107 meters), 95° 51'.8; north corner of recreation reserve, 180° 40'.4; near gable end of race-course building, three-fourths mile (1.2 kilometers), 253° 20'.0; east corner of recreation reserve, 450 feet (137 meters), 295° 15'.4; south corner of recreation reserve 349° 14'.6.

Mackay, Queensland, 1913.—In small triangular showground reserve bounded by Albert, Milton, and Alfred streets, 256 feet (78.0 meters) from southeast corner of reserve, and 134.5 (40.99 meters) from south fence of reserve; marked by hardwood peg driven flush with ground. True bearings: southwest corner fence post, 350 feet (107 meters), 206° 39'.2; top of steeple of Lutheran church, 1,000 feet (305 meters), 256° 16'.2; tower of girls' public school, one-third mile (0.5 kilometer), 278° 14'.9; southeast corner fence post, 309° 04'.6.

Malvern Bore, Queensland, 1913.—Near a bore which was being sunk at Malvern Hill station, said to be about 1.5 miles (2.4 kilometers), north of railway line, and about 7 miles (11 kilometers) from Benlidi railway station.

Mansfield, Victoria, 1913.—On prominent hill near old triangulation station in Mr. Nicholas's paddock, just north of township; marked by wooden stake set flush with ground. True bearings: center of high rock on Stony Point brick building, 2.5 miles (4 kilometers), 14° 23'.0; top right edge of right brick chimney of courthouse, three-eighths mile (0.6 kilometer), 42° 58'.2; center of high ornament over Conlan's Delatite Hotel, three-eighths mile (0.6 kilometer), 47° 26'.7; center roof gable of Mansfield railway station, five-eighths mile (1 kilometer), 72° 04'.2; top right edge of railway water tank, five-eighths mile (1 kilometer), 80° 43'.5; center of cairn on "Paps," 6 miles (10 kilometers), 93° 31'.8; center of stone cairn on Mt. Battery, 3 miles (5 kilometers), 249° 29'.4; center of left ornament of tower of large brick building, 1 mile (1.6 kilometers), 355° 54'.6. Neumayer's station was about one-half mile (0.8 kilometer) north of this point.

Mapoon Mission, Queensland, 1913.—In north corner of Aboriginal Mission Huts Reserve and adjacent to mission's cocoanut plantation, 68.5 feet (20.88 meters) from north corner post of reserve; marked by hardwood post 4 by 4 by 24 inches (10 by 10 by 61 cm.) sunk just beneath surface. True bearings: near gable end of mission hut, 1,000 feet (305 meters), 21° 37'.6; north corner post of reserve, 160° 54'.9, spike on roof of church, 313° 52'.7; center of near front post of front porch of church, 314° 59'.2.

Maryborough, Queensland, 1913.—In south corner of north portion of public park reserve bounded by Cheapside and Gayndah Road, 267 feet (81.4 meters) from south corner post of reserve, and 180.5 feet (55.01 meters) from southeast boundary fence; marked by hardwood peg sunk just below ground. True bearings: left ornament on roof of church, 1.3 miles (2 kilometers), 208° 47'.0; east corner of reserve, 900 feet (274 meters), 231° 04'.6; center of right tower of building in showgrounds, 1,200 feet (366 meters), 307° 10'.4; south corner of reserve, 356° 38'.8.

Mayne Junction Hotel, Queensland, 1913.—On open flat east of hotel buildings and southeast of water-hole inclosure, 166 feet (50.6 meters) from east corner and 140 feet (42.7 meters) from south corner of fence around water hole, marked by hardwood peg sunk level with surface. True bearings: south corner of water-hole fence, 86° 51'.5; near gable end of near hotel building, 390 feet (119 meters), 94° 10'.2; near gable end of front hotel building, 450 feet (137 meters), 98° 04'.1; east corner of water-hole fence, 164° 56'.2.

Meekatharra, Western Australia, 1912.—In northwest corner of recreation ground, 97 feet (29.6 meters) from north fence and 121 feet (36.9 meters) from west fence; marked by jarrah peg set below surface. True bearings: survey peg at northwest corner of grounds, 150° 11'.5; center of gage on top of same hill as Luke Creek trigonometric station, 271° 05'.0; center of cross on left gable end of Catholic church, 322° 33'.5. Declination observations were also made at secondary station 36 paces from main station, in direction of center of gage on top of hill.

Melbourne, Victoria, 1911, 1913.—Four stations were occupied at Melbourne Observatory. Station *A* is magnetometer pier in absolute house. Station *B* is on lawn of observatory, midway between main gate and office, and is approximately the same as that

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AUSTRALIA—*continued.*

Melbourne, Victoria, 1911, 1913—continued. occupied by Austrian Naval Expedition. It is 23 feet (7 0 meters) northwest of edge of main walk and marked by drill hole in top of sandstone block about 6 inches (15 cm.) square, sunk 2 inches (5 cm.) in ground and marked C I W. 1911. True bearings: north corner of house at gate, about 100 feet (30 meters), 56° 19′, southwest corner of absolute house, 116 5 feet (35 51 meters), 145° 12′; chimneys of stone building, about 400 feet (122 meters), 178° 16′ and 180° 59′ respectively; near corner of main observatory building, 106.7 feet (32.52 meters), 240° 06′. The dip-circle pier and earth-inductor pier in absolute house were also occupied, being designated "Dip Pier" and "E. I. Pier" respectively

Menindie, New South Wales, 1913.—On bank of Darling River, in large recreation reserve bounded by Pruella and Holding streets, 80.5 feet (24.54 meters) from survey peg marking west corner of reservation, marked by hardwood peg sunk just below surface of ground True bearings: west corner survey peg, 83° 07′.5; near corner of chimney of Crown Hotel, one-fourth mile (0 4 kilometer), 105° 29′.5; near end of roof of Roman Catholic church, one-fourth mile (0 4 kilometer), 161° 05′ 6; spike on rear end of roof of hall, one-fourth mile (0.4 kilometer), 165° 16′ 7.

Menzies, Western Australia, 1912.—In recreation grounds north of town and on west side of railway, 231.5 feet (70 56 meters) from east fence, and 109 feet (33 2 meters) from south fence; marked by jarrah peg set below surface True bearings· iron pole on knoll, 95° 20′ 1, left edge of grandstand at bottom, 113° 16′ 4. Declination observations were also made at secondary station 30 paces from main station in direction of iron pole on knoll

Merredin, Western Australia, 1912—South of Merredin Peak, 137 5 feet (41 91 meters) northwest of northwest corner of fence surrounding reservoir of Merredin Peak catchment reserve; marked by jarrah peg sunk just below surface True bearings· trigonometric station on Merredin Peak, 196° 11′ 7; northwest corner of fence around dam, 320° 53′ 9; center of chimney of pumping plant alongside dam, 344° 37′.4

Mien, Queensland, 1913—In paddock of telegraph station at Mien, northwest of station building and southeast of yards, 95.5 feet (29 11 meters) from southeast corner of yards and about 12 feet (3.7 meters) northeast from small track between yards and station; marked by boxwood stake sunk just below ground. True bearings: southeast corner of yards, 108° 41′.8; leftmost veranda post of telegraph station, 460 feet (140 meters), 296° 31′.7; right gable end of near wing of station building, 460 feet (140 meters), 300° 49′.0; right gable end of far wing of station building, 302° 27′.6.

Mildura, Victoria, 1911—In football grounds belonging to town, in block between 11th and 12th Streets and southeast of San Mateo Avenue, 247 feet (75.3 meters) from 11th Street fence and 107 feet (32.6 meters) from cross-fence to the northwest. True bearings tip of belfry of school, 118° 49′.7; rear edge of small grandstand in grounds, 347° 27′.9.

Milner's Well, Northern Territory, 1912—On wagon road about 1 mile (1.6 kilometers) south of Milner's Well and about 20 yards (18 meters) west of telegraph line.

Milparinka, New South Wales, 1913.—On west bank of creek, on northeast side of town, between creek and road to Cobham Lake and on north bank of small creek tributary to main one; marked by hardwood

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AUSTRALIA—*continued.*

Milparinka, New South Wales, 1913—continued. peg sunk just below surface of ground True bearing: near gable end of Royal Standard Hotel, one-fourth mile (0 4 kilometer), 120° 43′.3

Mingenew, Western Australia, 1912—In public reserve between Ikewa Street and Yandanooka Road, 179.5 feet (54 72 meters) from telegraph pole which is in near fence line of latter, 330 5 feet (100 74 meters) southeast of survey post at corner of reserve at intersection of these streets. True bearings: center of cross on Catholic church, 90° 50′ 4; point on top of Mingenew Hill, probably survey post, 122° 09′.4, top of pipe feeding railway tank, 160° 43′.8.

Mooketa Rock Hole, Northern Territory, 1912—About 300 yards (274 meters) south of rock hole locally called Mooketa, or Muckety

Moora, Western Australia, 1912—In recreation grounds, 297.5 feet (90.68 meters) from west fence, and 373.5 feet (113.84 meters) from southwest corner of grounds, marked by jarrah peg set below surface. True bearings: survey post in southwest corner of grounds, 373 5 feet (113.84 meters), 42° 42′.7; survey post in northwest corner of grounds, 400 feet (121 9 meters), 135° 14′.2; right gable end of large shed in show-grounds, 800 feet (243 8 meters), 325° 45′.4.

Moree, New South Wales, 1913.—In northeast corner of recreation reserve between Albert Street and Gwydir River, 239 feet (72 8 meters) southwest of northwest corner of cricket ground, and 118 feet (36.0 meters) south-southeast from left post of gate opposite end of Boston Street. True bearings: left post of large gate, 173° 47′.7; northwest corner of fence around cricket ground, 240° 30′.8; top of near gable end of grandstand in cricket ground, 300 feet (91 meters), 296° 33′.7.

Morgan, South Australia, 1911.—A short distance east of top of hill across gully to south of town, 597 feet (182 0 meters) west of semaphore pole and about 300 yards (274 meters) northeast of farther one True bearings: top of farther railway semaphore pole, 47° 20′ 5; ornament on left gable end of brewery, 186° 42′ 0; wind vane on telegraph office, 216° 55′ 9; top of near railway semaphore pole, 287° 26′ 3.

Moruya, New South Wales, 1913.—In northeast corner of public recreation reserve containing the racecourse, 124 feet (37 8 meters) south of north fence, and 266 feet (81 1 meters) southwest of northeast corner fence post; marked by hardwood peg sunk just below surface of ground. True bearings: near gable end of race-course grandstand, 700 feet (213 meters), 57° 59′.7; right turret in front of church, one-half mile (0.8 kilometer), 142° 44′.1; center of front of roof over dormer window on right front of Keating's Hotel, one-third mile (0.5 kilometer), 147° 38′.6; left end of freight shed at wharf, one-half mile (0.8 kilometer), 178° 08′.3; center of bottom of northeast corner post of fence, 252° 06′.6.

Mount Douglas, Queensland, 1913—In station paddock, about 100 yards (91 meters) northwest of station. True bearings: left support of meat gallows, 61 paces, 187° 16′.7; near gable end of station house, 300 feet (91 meters), 310° 49′.5.

Mount Hope, South Australia, 1911.—About 1 mile (1 6 kilometers) from Mount Hope post office, on small rise on west side of road from Port Lincoln, about 250 yards (229 meters) south of boarding house "Travellers' Rest," 160 paces south of an east-west wire fence and 243 feet (74.1 meters) from fence at roadside, 65 5

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AUSTRALIA—*continued.*

Mount Hope, South Australia, 1911—continued. feet (20 0 meters) from a she-oak tree to south, and 55.5 feet (16 9 meters) from another to southwest. True bearings. left edge of hill slope, 6 miles (10 kilometers), 143° 54′.1; near corner of shed built of stone and iron, 205° 23′.2.

Mount Magnet, Western Australia, 1912.—Three stations, designated *A*, *B*, and *C*, were occupied. *A* is about three-fourths mile (1.2 kilometers) east of railway, at edge of village, in open space outside recreation grounds, and in line with south fence, and 139.5 feet (42 52 meters) east of southeast corner; marked by jarrah peg True bearings: center of water-supply tank, 71° 18′.4 ; southeast corner of recreation grounds, 89° 52′ 8; Mount Magnet trigonometric station, 138° 46′.7. *B* is on Mount Magnet, about 3 miles (5 kilometers) northwest of *A*, and about 5 feet (1.5 meters) southeast of trigonometric station. *C* is on Mount Magnet, 132 feet (40.2 meters) south of *B* in line to chimney of Morning Star mine, the true bearing of which is 1° 06′.6. Three auxiliary stations, designated *D*, *E*, and *F*, were also occupied. *D* is about two-thirds down the mount, a little to east of line to Morning Star mine; *E* is under face of hill at its foot, beyond end of rifle range, from which isolated peak bears 282° 26′.6; *F* is 275 paces from *E* in direction of isolated peak.

Mount Pleasant, Federal Territory, 1913 —Near top of hill occupied by Royal Military College Observatory, 181 feet (55.2 meters) northeast of nearest corner of entrance porch of observatory; marked by hardwood peg projecting above surface of ground. True bearings: Mount Pleasant Observatory, 46° 05′.4; Mount Stromlo Observatory, 8 miles (13 kilometers), 81° 35′.5; Canbera church spire, 1.5 miles (2.4 kilometers), 125° 01′.4; trigonometric station on Mount Ainslee, 2 miles (3 kilometers), 179° 15′.3; right edge of right chimney of officers' quarters at Royal Military College, one-half mile (0.8 kilometer), 285° 41′ 3.

Mount Samuel, Northern Territory, 1912.—Near Mount Samuel, about 50 yards (46 meters) west of telegraph line.

Mount Stromlo, Federal Territory, 1913.—Near Federal Observatory, just below top of hill and 156 feet (47.6 meters) northwest of northwest window of observatory, marked by hardwood peg set flush with ground. True bearings: trigonometric station on high mountain, 8 miles (13 kilometers), 41° 17′.0; Canbera church steeple, 7 miles (11 kilometers), 255° 16′.4; Mount Pleasant Observatory, 8 miles (13 kilometers), 262° 00′.2; center of northwest window of observatory, 316° 01′.7. Auxiliary stations 1 and 2 were occupied 28 paces 262°.0 west of south, and 17 paces 82°.0 west of south, from main station, respectively.

Murray Bridge, South Australia, 1911 —Near center of football field owned by town council, on "Telegraph Road" just beyond road which branches off near field, 213 feet (64 9 meters) from west goal post, 234 feet (71.3 meters) from gate to northwest, 231 feet (70.4 meters) from nearest veranda post of small shed or pavilion to west, and 232 feet (70.7 meters) from gate southeast. True bearings: right edge of small pavilion, 86° 27′.4; bottom cross on front of small new church, one-third mile (0 5 kilometer), 182° 41′.9; left edge of left support of large water-supply tanks, one-fourth mile (0.4 kilometer), 247° 26′ 2 Dip observations were made at secondary station 50 7 feet (15.45 meters) south of main station.

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Musgrave, Queensland, 1913 —On ant-bed flat northwest of telegraph-station inclosure, in large paddock between station and yard creek, and 290 5 feet (88 54 meters) from northwest corner of killing yards; marked by hole in top of hardwood stake sunk just below ground True bearings: northeast corner of station inclosure, 520 feet (158 meters), 290° 22′.8; leftmost veranda post of telegraph station building, 500 feet (152 meters), 297° 51′ 7; northwest corner of station inclosure, 370 feet (113 meters), 298° 36′.2; near gable end of near wing of station building, 500 feet (152 meters), 301° 02′.2; near gable end of far wing of station building, 500 feet (152 meters), 303° 57′ 2; northwest corner of killing yards, 329° 56′ 8.

Nanwoora, South Australia, 1911 —On rise north of station house and west of main road, 53 paces southwest of hut and one-fourth mile (0 4 kilometer) from tank and windmill, the pipe of which is in true bearing 258° 52′ 7

Narrabri, New South Wales, 1913 —On hill called by Survey Office "Beelera" and known locally as Little Mountain, about 2 miles (3 kilometers) northeast from township, in quarry reserve No. 14529, 204 feet (62.2 meters) distant from the Survey Department's astronomical station. True bearings: center of circular ventilator in near end of W. H. Short & Co 's Excelsior Flour Mill, 2 miles (3 kilometers), 50° 01′.3; tower of town hall, 2 5 miles (4 kilometers), 60° 47′ 6; astronomical station, 238° 49′.0.

Narrandera, New South Wales, 1913.—In quarry reserve north of railway station, 398 feet (121.3 meters) north-northeast of trigonometric station, and about same distance north-northeast of water tower. True bearings: bottom of trigonometric pole, 38° 06′ 0, Cudgello trigonometric station, 8 miles (13 kilometers), 150° 01′.8.

Narrogin, Western Australia, 1912 —About one-half mile northwest of railway station, in showgrounds, in the line of row of young pine trees, 77 5 feet (23.63 meters) west of east fence and 239 feet (72 8 meters) from survey post at southeast corner of grounds; marked by jarrah peg sunk 2 inches below ground True bearings: cross on Roman Catholic church, 0° 25′ 7; flagstaff on near gable end of large shed, 151° 41′.1, survey post at southeast corner of grounds, 342° 38′ 6

Newcastle Waters, Northern Territory, 1912.—In stockyard south of railway station, 31 5 feet (9 60 meters) northeast of lone gutta-percha tree in line toward station quarters, 377 feet (114 9 meters) southwest of telephone post nearest station house, and 266 feet (81.1 meters) southeast of left gatepost at northwest corner of stockyard, marked by wooden peg set just below surface. True bearings. right support of meat gallows at top, 95° 26′.5; left gatepost at northwest corner of stockyard, 151° 01′.1; right gatepost on south side of yard, 304° 09′ 6. Declination was observed also at a secondary station about 165 feet (50 meters) north 72° east of main station

Normanton, Queensland, 1912.—On spur of rise about three-fourths mile (1 2 kilometers) southeast of town and about 1 mile (1 6 kilometers) south of wharf at foot of Lansborough Street; marked by jarrah peg projecting slightly above ground. True bearings: cross on left end of Catholic church, three-fourths mile (1.2 kilometers), 75° 38′.4; ornament on left gable end of Methodist church, one-half mile (0 8 kilometer), 94° 20′ 1; flagstaff on Hely's Hotel, three fourths mile (1 2 kilometers), 108° 53′.2; center of ventilator on top of Divisional Board's Hall, three-fourths mile (1 2 kilometers), 127° 06′.9; flagstaff over Burns Philp &

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AUSTRALIA—*continued.*

Normanton, Queensland, 1912—continued
Company's store, 138° 58′.1, top of telegraph tower on far side of river, 1 mile (1 6 kilometers), 217° 08′ 2; near corner of small stone building at hospital, one-third mile (0.5 kilometer), 348° 20′.0.

Norseman, Western Australia, 1912.—Near center of tract of land reserved for warden's quarters on shore of Lake Cowan, 424 feet (129 2 meters) from survey peg No 3551 at northeast corner of reserve, 313 feet (95 4 meters) from north boundary, and about in line with old fence on south side of warden's house site; marked by round wooden peg driven in ground. True bearings: front edge of nearby house, 195° 47′.5; bottom of large chimney of Mararoa Mine, 2.5 miles (4 kilometers), 267° 58′ 5; left edge of fire department water tank in town, 282° 34′.0

Northam, Western Australia, 1912—In public park and gardens reserve between Clarke Street and the River Avon, about midway between river and Clarke Street and in line with fence on southwest side of sanitary plot and 1,155 7 feet (352 26 meters) southeast of survey post at Clarke Street corner, at which line to station makes an angle with side of Clarke Street of 39°; marked by jarrah peg driven flush with ground and to be protected by fence True bearings: chimney of electric-light plant, 1 mile (1 6 kilometers), 6° 29′ 0, center of inscription on tombstone of Mr. Throstle, 2 miles (3 kilometers), 258° 57′.8; bottom of pole supporting wind vane on center tower of Anglican church, 1 mile (1.6 kilometers), 333° 28′.7.

No. 3 Well, Northern Territory, 1912.—About 100 yards (91 meters) southwest of well.

Nyngan, New South Wales, 1913.—Near northwest corner of Nyngan Park, and 121 feet (36 9 meters) southwest of northeast fence; marked by hardwood peg sunk just beneath surface of ground True bearings: flagstaff over tennis pavilion, 300 feet (91 meters), 18° 37′.8, northwest corner post of park, 144° 44′ 8; center of cross on Roman Catholic church, 149° 37′ 4; center of front of town hall, 210° 50′.0; center of top of courthouse tower, 600 feet (183 meters), 242° 56′.8; right edge of tank on water tower, 500 feet (152 meters), 292° 41′.2; right flagstaff on sports pavilion, 600 feet (183 meters), 325° 05′ 3

Olary, South Australia, 1911.—On low ridge running parallel with railway line, about one-third mile (0.5 kilometer) north of railway station; marked by red-gum peg 3 by 3 inches (8 by 8 cm.) sunk flush with ground. True bearings. chimney pipe of Olary Hotel, 425 meters, 2° 38′.9; trigonometric cairn on hill, 6 kilometers, 107° 33′.4; semaphore signal post, 790 meters, 295° 34′.8; east edge of railway water tank, 490 meters, 349° 02′ 7.

Omeo, Victoria, 1913—In southeastern portion of police paddock, between township and public hospital, 76 feet (23 2 meters) east from southwest corner post of fence around paddock. True bearings: top left edge of corner post at southwest corner of fence, 82° 34′ 8; bottom left edge of small barred window in back of post-office building, 152° 37′ 8; center top ornament over top gable of butter factory, 156° 17′.8; top left edge of brick chimney of hospital, 327° 44′.7. Neumayer's station was about one-half mile (0 8 kilometer) north of this point

Oodnadatta, South Australia, 1911, 1912.—West of township and about 600 yards (549 meters) west of railway station, about 600 yards (549 meters) west-northwest of school, about 100 yards (91 meters) west of square wooden house with a veranda on three sides, 298 2 feet (90.89 meters) northwest of galvanized-iron stable, and 265 5 feet (80 93 meters) west of nearest corner of police stable; marked by jarrah peg. True bearings: trigonometric station on hill, 3 miles (5 kilometers), 183° 35′ 6, east corner of railway water tank, 249° 24′ 1; flagpole on Transcontinental Hotel, 290° 56′ 3.

Ooraminna Well, Northern Territory, 1912.—About 12 feet (3 5 meters) east of telegraph line, at foot of hill, about one-half mile (0.8 kilometer) north-northeast of well, and 90 5 feet (27.58 meters) from nearest telegraph pole to south. True bearing: left edge of tank at well, 21° 15′.2

Orange, New South Wales, 1913.—In Anson Reserve for water and recreation purposes fronting on Anson Street between Kite and Moulder streets, 81 feet (24 7 meters) from west fence, and 276 5 feet (84.28 meters) from southwest corner fence post True bearings center of southwest corner fence post, 26° 31′ 0, center of top of finial on near gable end of Cara House, 200 feet (61 meters), 119° 30′ 9; center of bottom of flagstaff over land office, 330 feet (101 meters), 187° 01′.1; center of bottom of flagstaff over Willcocks's merchandise warehouse, 800 feet (244 meters), 237° 42′ 9

Perth, Western Australia, 1912.—In bush on highest portion of King's Park, a short distance west of drive on east side overlooking Swan River; by computation 7,206 links (1,449.6 meters) south and 3,645 links (733.3 meters) west of transit circle of observatory; marked by pointed jarrah post 6 by 6 by 36 inches (15 by 15 by 91 cm.) projecting 18 inches (46 cm.) above ground, and marked C.I.W 1912 on side.

Petersburg, South Australia, 1911—In northwest corner of park reserve, about one-half mile (0 8 kilometer) almost due north of town hall; 284 feet (86 6 meters) from westernmost pillar of park gates, 275 feet (83.8 meters) from road fence to south, marked by peg of jarrah wood 4 by 4 inches (10 by 10 cm) set a little below surface of ground True bearings: nearest corner of west pillar of park gates, 328° 05′ 5; gable of town hall, 351° 16′.2

Pine Creek (Playford), Northern Territory, 1912—On township reserve southeast of police station, on line between railway water tank and galvanized-iron house south of police station, and also nearly on line from northwest corner of hotel toward Gandy's trigonometric station, 171 feet (52.1 meters) and 253 feet (77.1 meters) respectively from south and east corners of fence around police station; marked by paper-bark peg sunk just beneath surface. True bearings: bottom of pole on Gandy's trigonometric station, one-half mile (0.8 kilometer), 114° 26′.8; left edge of warden's office, 219° 40′ 9; northwest edge of railway tank, 267° 01′.5; left edge of hotel, about 500 feet (152 meters), 285° 09′.3

Pinnaroo, South Australia, 1911—In a park reserve between townships of Pinnaroo and Mackenzie, about one-third mile (0 5 kilometer) south of railway, about 140 yards (128 meters) due south of Pinnaroo Hotel, and 174 5 feet (53 19 meters) south-southeast and 202 feet (61.6 meters) south-southwest from two street corners; marked by jarrah peg 2 by 3 by 20 inches (5 by 8 by 51 cm) set just below surface of ground. True bearings: east edge of back chimney of Pinnaroo Hotel, 180° 55′.0; northwest street corner, 176° 53′; northeast street corner, 195° 12′.

Port Darwin, Northern Territory, 1912—In Botanical Gardens near north end of Mindil Beach, 55 feet (16 8

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Port Darwin, Northern Territory, 1912—continued. meters) northwest of center of road running southwest through avenue of cocoanut palms measured from point in road 62 feet (18 9 meters) southwest of intersection with center of roadway running southeast; 115 feet (35.1 meters) south of post on north side of latter roadway, and 104 feet (31 7 meters) north of northernmost cocoanut tree in row east of avenue, marked by drill hole in top of concrete block 6 by 8 by 13 inches (15 by 20 by 33 cm.) sunk flush with ground and lettered on top C. I W. 1912. True bearings. lighthouse on Point Charles, 15 miles (24 kilometers), 105° 05′.7; right edge of cliff to northwest, 2 miles (3 kilometers), 153° 29′.3.

Portland, Victoria, 1912 —In public reserve between coast line and Bentinck Street, 550 yards (503 meters) south-southwest from lighthouse, 241 feet (73.5 meters) and 210.5 feet (64.2 meters) respectively northeast and southeast from north and south ends of stone wall in front of Benevolent Asylum, probably about one-tenth mile (161 meters) north of Neumayer's station; marked by wooden peg driven flush with ground. True bearings: top right edge of Portland post office, 3° 41′.7, top of Roman Catholic church steeple, 9° 56′.2; top of cross on steeple of Roman Catholic convent, 10° 22′.6, top right edge of right wing of Benevolent Asylum, 300 feet (91.4 meters), 112° 57′.8; center of weather vane over center of lighthouse, 203° 44′.9; mouth of old cannon at old lighthouse site, 327° 22′.1; top of beacon lamp on shed on middle jetty, 337° 00′.8. Declination observations were also made at secondary station 36 yards from main station in direction of Roman Catholic church.

Port Lincoln, South Australia, 1911.—In small park adjoining football oval, in third block from beach and northwest of school grounds, 144 feet (43.9 meters), 156 feet (47.6 meters), and 133 feet (40.5 meters), respectively, from southeast, southwest and northeast fences. True bearings. center of bottom of iron ornament on front of English church, 219° 42′.8; center of bottom of stone ornament on front of Methodist church, 277° 17′.1; Flinders monument on distant hill, 309° 33′.7; left gable end of red-roofed house beyond school, 329° 01′.1.

Port Macquarie, New South Wales, 1913.—In southwest part of Port Macquarie Park at corner of Owen and Burrawan streets, 168 feet (51.2 meters) from southwest corner fence post, and 74 feet (22 6 meters) from west fence; marked by hardwood peg. True bearings. southwest corner fence post of park, 22° 35′; right gable end of pilot's house, 1,000 feet (305 meters), 185° 47′.9; bottom of flagstaff at pilot station, one-fourth mile (0 4 kilometer), 215° 32′.6; bottom of flagstaff on skyline, one-fourth mile (0 4 kilometer), 338° 25′ 4.

Port Pirie, South Australia, 1911 —Two stations, *A* and *B*, were occupied in park lands reserved southwest of business portion of town. *A* is 197 feet (60 0 meters) west of fence inclosing football ground, 410 feet (125 0 meters) north of street fence, and about 750 feet (229 meters) east of public school; marked by jarrah peg 3 by 3 by 20 inches (8 by 8 by 51 cm.) set somewhat below surface True bearings: ornament on southwest gable of public school, 87° 52′ 6; flagpole on tower of Federal Hotel, 0 4 kilometer, 158° 54′.0; largest chimney of smelting works, 1.2 kilometers, 202° 13′.9; dome with spire of Barrier Hotel, 0.8 kilometer, 222° 50′.6 *B* is almost due south of *A*, 430 feet (131 meters) south of road fence, and 900 feet (274 meters) from *A*. True bearings. ornament on southwest

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Port Pirie, South Australia, 1911—continued gable of school, 124° 14′.6; flagpole on tower of Federal Hotel, 154° 24′ 8; dome and spire of Barrier Hotel, 203° 31′.0.

Port Victor, South Australia, 1911.—On hill about 2 miles (3 kilometers) northwest of town, in southeastern part of quarry reserve belonging to town, 103 5 feet (31.55 meters) from south fence, and 136.5 feet (41.60 meters) from northeast fence inclosing reserve, marked by jarrah peg 2 by 3 by 20 inches (5 by 7 by 51 cm.) set a short distance below surface. True bearings: highest chimney in old tower, 3 kilometers, 262° 15′.0; gable of red brick store in town, 3 kilometers, 283° 57′.8; flagpole on Granite Island, 3 kilometers, 295° 42′.8.

Port Wakefield, South Australia, 1911 —In Council Reserve of about 40 acres, east of town and between two cross roads; about 120 yards (110 meters) southeast of railway line, one-third mile (0.5 kilometer) from railway station and post office, 400 yards (366 meters) northwest of stone shed in show grounds, 120 yards (110 meters) north-northeast of stone cottage, 320 feet (47.5 meters) from corner of fence inclosing cottage, 270 feet (82 3 meters) from boundary fence to northwest, 390 feet (118.9 meters) from boundary fence to south, and about 295 feet (90 meters) from gravel pit. True bearings: semaphore signal post, 0 5 kilometer, 85° 37′.4; north gable of stone shed in show-grounds, 307° 20′.1.

Powell's Creek, Northern Territory, 1912 —On flat across creek east of telegraph station, about 300 feet (91 meters) from telegraph station and 263 feet (80.2 meters) from first telegraph pole south of it; marked by sandalwood peg sunk just beneath surface. True bearings. center of windlass over well in garden, 23° 01′ 9, northeast corner of telegraph office, 92° 20′.3. Declination observations were also made at secondary station about 120 feet (37 meters) west of main station.

Quorn, South Australia, 1911.—In park lands south of railroad and about one-half mile (0.8 kilometer) southwest of railroad station, 600 feet (182.9 meters) east from far corner of road bounding park on southwest, 487 feet (148 4 meters) south of near corner of street that runs to railway station, 359 7 feet (109 64 meters) southwest of near corner and 373 3 feet (113.79 meters) west of far corner of second street south of railway station, and 5 feet (1.5 meters) north of building line along north side of this street. True bearings: front gable on railway shed, 66° 40′.8; center at top of chimney of old flour mill, one-half mile (0.8 kilometer), 225° 24′ 3.

Red Hill, New South Wales, 1913.—Intercomparison observations were made at magnetic hut west of Red Hill Observatory branch of Sydney Observatory at Pennant Hill. Two stations, designated *A* and *B*, were occupied. *A*, same as station of 1906, is sandstone pillar in magnetic hut. True bearings: *B*, 205° 44′.4; white line on sandstone pillar, azimuth mark of observatory, 200 feet (61 meters), 250° 49′.4 *B* is 94 5 feet (28.80 meters) north-northeast from *A*.

Renmark, South Australia, 1911.—In grounds of Anglican church, near bank of River Murray, 43.5 feet (13.26 meters) from northeast fence of church grounds, 59 5 feet (18 14 meters) from nearest corner of Sunday school, 114 feet (34 8 meters) from vestry door of church, and about 50 feet (15 meters) southeast of stable True bearing: gable end of Settlers' Club, one-third mile (0.5 kilometer), 356° 12′.2.

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Renner Spring, Northern Territory, 1912.—In open space about 550 feet (168 meters) west of Renner Spring, 1,100 feet (335 meters) northwest of stockyard and 500 feet (152 meters) east-southeast of isolated rocky knoll. True bearing: near fork of left support of meat gallows in stockyard, 318° 14′.7.

Richmond, Queensland, 1913.—In or near old water reserve on Flinders River, 58.5 feet (17.83 meters) from west corner of fence around O'Keefe's old cottage, 125 feet (38 1 meters) from south corner of same fence True bearings: ventilator over postmaster's house, one-half mile (0 8 kilometer), 1° 00′ 3; ventilator over courthouse, one-half mile (0.8 kilometer), 2° 31′.2; survey peg at north corner of section XXXV, one-fourth mile (0 4 kilometer), 65° 26′ 0; west corner of fence around O'Keefe's cottage, 240° 23′ 1; south corner of fence around O'Keefe's cottage, 286° 29′.3; left ventilator of Federal Palace Hotel, two-thirds mile (1.1 kilometers), 359° 19′ 5.

Rockhampton, Queensland, 1913.—In recreation reserve bounded by North and Campbell streets, 396.5 feet (120 85 meters) from north corner of reserve at Exhibition and Lion Creek roads, and 160 5 feet (48 92 meters) from northeast boundary fence; marked by hardwood peg sunk just below ground. True bearings center of tower on roof of school, one-half mile (0 8 kilometer), 26° 17′.4; center of cross on near end of church, one-half mile (0.8 kilometer), 46° 27′.2; east corner of fence inclosing stable, 200 feet (61 meters), 75° 08′.6; north corner of reserve, 157° 01′.4; bottom of flagstaff on roof of pavilion, 850 feet (259 meters), 209° 16′.2; east corner of reserve, 0.2 mile (0.3 kilometer), 300° 47′.0; spike on tower of Kent Brewery, one-fourth mile (0.4 kilometer), 311° 40′.2; north corner of immigration reserve, 530 feet (162 meters), 325° 07′.8.

Rolleston, Queensland, 1913 —In reservation containing police station, 69 5 feet (21.18 meters) from Comet Street fence, and 211 5 feet (64 47 meters) from north corner of reserve at Clematis Street, marked by peg sunk just below ground. True bearings: right edge of police station, 150 feet (46 meters), 19° 06′.6; near corner of inclosure containing station buildings, 80 feet (24 4 meters), 76° 43′.4; west corner of reserve, 260 feet (79 meters), 97° 25′.6; north corner of reserve, 161° 20′.7; east corner of reserve, 200 feet (61 meters), 297° 31′.1; near gable end of Planet Hotel, 500 feet (152 meters), 301° 06′ 1; near corner of lockup, 100 feet (30.5 meters), 359° 41′.5.

Roma, Queensland, 1913.—In recreation reserve at northwest end of Queen Street, near corner opposite latter, 166 5 feet (50 75 meters) from corner opposite Queen Street, and 23 5 feet (7.16 meters) from nearby gum tree; marked by hardwood peg driven flush with ground. True bearings. nearby gum tree, 23°, center of ornament on roof of hospital, 0.4 mile (0 6 kilometer), 45° 24′.1, southwest corner of reserve, 690 feet (210 meters), 85° 09′.2, east corner of reserve, 1,400 feet (427 meters), 239° 27′ 1, top of turret over courthouse, 0.4 mile (0 6 kilometer), 330° 08′.6; near corner of reserve, 354° 22′; center of cross over convent, 0 4 mile (0.6 kilometer), 356° 46′.5.

Rottnest Island, Western Australia, 1912 —About 12 miles (19.3 kilometers) from Fremantle, near camps constructed by Tourist Department of government of Western Australia for visitors; on highest point of low ridge running parallel to shore, east of jetty on seaward side of old road running along top of ridge; 161 feet (49 1 meters) from center of rotunda; marked by jarrah peg sunk just below ground. True bearings.

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Rottnest Island, Western Australia, 1912—continued. Rottnest Main Lighthouse, 2 8 miles (5 kilometers), 83° 22′.2; top of rotunda near jetty, 161 feet (49.1 meters), 177° 30′ 7; lighthouse at Bathurst Point, 1 mile (1.6 kilometers), 149° 42′ 6, trigonometric station on Point Phillip, one-third mile (0 5 kilometer), 278° 46′.4; trigonometric station on Mount Herschel, 1.2 miles (2 kilometers), 114° 45′ 4.

Ryan's Well, Northern Territory, 1912 —About 300 yards (274 meters) east-southeast from Ryan's Well, at edge of clearing and about 100 yards (91 meters) east of telegraph line. True bearing· top right edge of stone coping of well, 113° 01′.7

St. Lawrence, Queensland, 1913.—In northeast corner of race-course reserve, 165 feet (50 3 meters) from northeast corner survey peg, 88 5 feet (26 97 meters) from east fence. True bearings. northeast corner survey peg, 219° 18′ 5; front gable end of courthouse one-half mile (0 8 kilometer), 260° 15′.8; near gable end of house in police reserve, one-half mile (0 8 kilometer), 260° 40′ 0

Sandstone, Western Australia, 1912 —In race-course reserve, 232 5 feet (70 87 meters) northeast of road peg (marked R.10898) in southwest corner of reserve; marked by jarrah peg set just below ground. True bearings· southwest corner survey peg R 10898, 39° 04′.5; right or higher tower of National Hotel, 345° 40′.5.

Shepparton, Victoria, 1913.—Approximately one-half mile (0 8 kilometer) northwest of Neumayer's station; in rifle range reserve north of Goulburn River, 30 yards (27 meters) southeast of nearest gum tree, and 90 yards (82 meters) north of white gate of rifle range; marked by wooden peg driven flush with ground True bearings. center bolt in center of white gate of rifle range, 5° 39′.1; center of left foot of central statue (woman standing) on front of Australian Mutual Provident Society's building, one-half mile (0.8 kilometer), 311° 10′ 5.

Sorell, Tasmania, 1913.—Very closely a reoccupation of station of Magnetic Survey of Tasmania, on north side of easternmost by-road which leaves main Bellerive-Sorell road at a point 0.36 mile (0 58 kilometer) east of eleventh milestone from Bellerive. True bearing trigonometric station on Mt Rumney, 5.6 miles (9.0 kilometers), 45° 37′.7.

Southern Cross, Western Australia, 1912 —In large recreation ground north of railroad and in line with east fence of small Wesleyan cemetery within reserve, 100 feet (30.5 meters) north of northeast corner of cemetery; marked by jarrah peg sunk just below ground. True bearings. left edge of large water-supply tank on hill, 59° 46′ 9, top of belfry on Church of England, 79° 53′.3; center of front of Commercial Hotel, 91° 06′ 7.

Southport, Queensland, 1913.—In Queen's Park Recreation Reserve, 110 feet (33.5 meters) from east fence, and 303 5 feet (92 51 meters) from southeast corner at Queen Street and Parade; marked by hardwood peg sunk just below ground True bearings. spike on front of old church, 800 feet (244 meters), 75° 24′ 5; center of southwest corner post of park, 800 feet (244 meters), 87° 19′ 7; center of northwest corner post, one-fourth mile (0 4 kilometer), 124° 26′.8; center of small steeple on Roman Catholic church, one-half mile (0.8 kilometer), 156° 04′.8; southeast corner post, 303° 42′ 5.

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Stonehenge, Queensland, 1913.—In reserve containing police station, 130 5 feet (39 77 meters) from south corner of reserve, and 69 feet (21 0 meters) from southeast fence; marked by hardwood peg sunk 1 inch (3 cm.) below ground. True bearings: south corner survey post, 2° 24′; west corner survey post of reserve, 280 feet (85 meters), 101° 11′ 2, top of roof of police station, 480 feet (146 meters), 215° 48′.8; east corner of reserve, 550 feet (168 meters), 221° 23′.0; center of top of porch of post office, 200 feet (61 meters), 323° 23′.7.

Swan Hill, Victoria, 1913.—In public reserve on west bank of Murray River, 20 yards (18 meters) west from bank of river, 361 feet (110 0 meters) from fence post at northwest corner of reserve; marked by wooden stake set flush with ground. True bearings. top right edge of railway water tower, three-eighths mile (0.6 kilometer), 0° 56′ 9; left edge of left chimney of railway station, one-eighth mile (0.2 kilometer), 36° 24′.7; center of ornament over central entrance of hospital, one-half mile (0.8 kilometer), 83° 44′.1; center of fence post at northwest corner of reserve, 109° 53′.4; approximate site of old courthouse (Neumayer's station) one-fourth mile (0.4 kilometer), 132°, bottom left edge of lowest right window of water tower, 138° 55′ 3; top right edge of right concrete pier of bridge, one-eighth mile (0.2 kilometer), 158° 50′.3, bottom right edge of Federal Hotel on east side of river, one-fifth mile (0.3 kilometer), 195° 17′ 6

Sydney, New South Wales, 1913.—See Red Hill, also Garden Island.

Talia, South Australia, 1911.—Near top of rise south of boarding house and post office, the top being too rocky to drive pegs in; about 250 yards (229 meters) from post office; marked by small wooden peg. True bearing: right edge of right building of Talia boarding house, 190° 58′.7.

Tambo, Queensland, 1913.—In southwest corner of dam reserve, at corner of Arthur and Barcoo streets, 169 feet (51.5 meters) from southwest corner post of reserve, and 78.5 feet (23.92 meters) from fence bounding south side of reserve; marked by hardwood peg sunk just below ground. True bearings: southwest corner post of reserve, 46° 35′.2; southeast corner of reserve 500 feet (152 meters), 261° 08′.7; near gable end of building at Tambo station, 1.5 miles (2 kilometers), 283° 26′.1

Taroom, Queensland, 1913.—In show-ground reserve, 321.5 feet (98 00 meters) from fence post in north boundary fence, which is 852 feet (259 7 meters) from northwest corner of reserve; marked by hardwood peg sunk just below ground.

Taylor's Crossing, Northern Territory, 1912.—About 0 3 mile (0 5 kilometer) from well at point where telegraph line crosses Taylor's River, and about 250 feet (76 meters) southeast of sixth telegraph pole from well on north side.

Teatree Well, Northern Territory, 1912.—About 250 yards (229 meters) west-southwest of Teatree Well True bearing: top of wire rope running over pulley above well, 241° 25′.2.

Temple Bar, Northern Territory, 1912.—On road to Alice Springs, about 6 miles (10 kilometers) south of Temple Bar well, and about 100 feet (30 meters) east of telegraph line.

Tennants Creek, Northern Territory, 1912.—Near bank of Tennants Creek, east-southeast of telegraph station, 203 feet (61.9 meters) west-southwest from well, 51.2 feet (15.6 meters) north of red-gum tree, 92.8 feet (28 3 meters) northeast of larger red-gum tree, and about 90 feet (58 meters) east-northeast of well in garden on bank of creek, east of powder magazine, marked by hickory peg sunk just below surface. True bearings: top of ventilator of powder magazine, 500 feet (152 meters), 81° 47′.2; left edge of chimney of stone telegraph office, 660 feet (201 meters), 119° 08′.9

Tenterfield, New South Wales, 1913.—Near southeast corner of Douglas and Bulwer streets in Tenterfield Park, 320 feet (97.5 meters) from northwest corner fence post, and 98 feet (29 9 meters) from west fence; marked by hardwood peg projecting above ground True bearings: center of right gable of two center gables of school, 1 mile (1.6 kilometers), 124° 08′.1; northwest corner post of park, 171° 50′.9.

Thargomindah, Queensland, 1913 —On open flat northwest of town, near fenced inclosure known as Section XX, Allotment 4, 38 feet (11.6 meters) southeast of railway survey benchmark; marked by peg sunk just below ground. True bearings. southwest corner of paddock (XX.4), 530 feet (162 meters), 75° 59′; southeast corner of paddock, 210 feet (61 meters), 87° 17′, northeast corner of paddock, 650 feet (198 meters), 139° 43′.1, near corner of tower of old brewery, 0.5 mile (0.8 kilometer), 215° 58′.8; south corner of Gilmore and Sam's streets, 0 57 mile (0.92 kilometer), 303° 38′ 4, near gable end of post office, 0.58 mile (0.93 kilometer), 307° 58′.1; north corner of Dowling and Moore streets, 0.55 mile (0.89 kilometer), 332° 12′ 2.

Thursday Island, A, Queensland, 1912, 1913.—On military reserve north of fort and south of quarantine station, midway on high cliff north of valley between fort and first hill along beach, 150 yards (137 meters) south of garrison jetty; marked by red-gum peg 15 inches (38 cm.) long projecting 6 inches (15 cm) out of ground and surrounded with rocks. True bearings. bottom of channel marker, 78° 30′ 0, Goode Island Lighthouse, 4 miles (6 5 kilometers), 105° 06′.9, right edge of cable test house on Hammond Island, 135° 30′ 4, bottom of high flagstaff on fort, 295° 03′ 0.

Thursday Island, B and C, Queensland, 1912 —Station *B* is in recreation reserve north of Summer Street and east of road leading to slaughter yards, 100 yards (91 meters) from southwest corner of fence around reserve. True bearings: top of ventilator on galvanized-iron house, 150 yards (137 2 meters), 298° 36′ 2, bottom of flagstaff visible over Metropole Hotel, one-half mile (0 8 kilometer), 27° 00′.1; bottom of right edge of school flagstaff, one-fourth mile (0.4 kilometer), 45° 50′.9. Station *C* is 47 yards (43.0 meters) from *B* in azimuth 185° 33′.4

Toowoomba, Queensland, 1913.—In Queen's Park, near wooden gate in wire fence dividing park in north and south direction, 81 feet (24.7 meters) west of wire fence, 989.5 feet (301.60 meters) from corner of fence where it joins fence on west side of botanical gardens, marked by hardwood peg sunk just below ground. True bearings: center of top of tower of Technical College, 850 feet (259 meters), 42° 34′.8; top of steeple of Congregational church, one-fifth mile (0.3 kilometer), 64° 19′.8; center of left gatepost at northwest corner, 850 feet (259 meters), 146° 21′.6; corner of fence and botanical gardens, 236° 42′.4; near corner of fence of botanical gardens, 800 feet (244 meters), 252° 07′.3.

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Townsville, Queensland, 1912, 1913.—On land reserved for defense purposes, on golf links west of Isley Street, north of its intersection with Eyre Street, 345.5 feet (105.31 meters) north of fence post at south corner of intersection, 353 feet (107.6 meters) west of strainer post at intersection of line fence with east side of Isley Street, and 350 feet (106 7 meters) southwest of the southwest corner of shed on golf links; marked by wooden peg driven flush with ground. True bearings: right ventilator over bishop's palace, 48° 37′.3; center of right ventilator over fort, 212° 05′.7; bottom of right flagstaff over fort, 230° 22′.3; top of steeple of Anglican cathedral, 318° 27′.5; top of ventilator over school, 324° 59′.0.

Urandangi, Queensland, 1913 —In north corner of State School Reserve at corner of Mary and William streets, 245 feet (74.7 meters) from east peg of reserve; marked by small stake sunk just below surface. True bearings: near gable end of school kitchen, 260 feet (79 meters), 0° 54′.1; center of ornament on post office, 1,000 feet (305 meters), 68° 53′.1; left gable end of hotel building, 800 feet (244 meters), 81° 10′.1; west survey peg of reserve, 500 feet (152 meters), 100° 56′.2, north survey peg of reserve, 420 feet (128 meters), 141° 33′.1; east peg of reserve, 301° 33′.9.

Vergemont, Queensland, 1913.—On open ground of slope east of station buildings, 109.5 feet (33.38 meters) from north fence of home paddock, and 370 5 feet (112 93 meters) from corner of fence and cattle yards, marked by hardwood peg sunk just beneath surface. True bearings· gum tree 120 feet (37 meters), 16° 42′; near gable end of workmen's quarters, 500 feet (152 meters), 45° 42′.2, right gable end of station house, 500 feet (152 meters), 54° 51′.5; right gable end of blacksmith shop, 400 feet (122 meters), 82° 18′ 8; near gable end of stockyard building, 400 feet (122 meters), 102° 03′.9; corner of fence and yards, 127° 06′.1.

Wagga Wagga, New South Wales, 1913.—In common on north side of Murrumbidgee River, about one-fourth mile (0 4 kilometer) east-southeast of bridge over river and about 20 paces south of telegraph line. True bearings: weather vane over post office, one-half mile (0 8 kilometer), 19° 19′.4; center of leftmost pillar under bridge, 113° 27′.0; gum tree, 18 paces, 174° 3; gum tree, 16 paces, 200°.3; near cross over small church seen across bridge over branch stream, one-half mile (0.8 kilometer), 223° 55′.6; ornament on right end of church on east side of street, one-third mile (0.5 kilometer), 337° 17′.9; center of cross on near end of church on west side of street, one-third mile (0 5 kilometer), 343° 40′ 8.

Walgett, New South Wales, 1913.—On recreation reserve, between Montkeila Street and Namoi River, 92.5 feet (28.19 meters) from Montkeila Street fence, and 122 5 feet (37 34 meters) from gate at corner of Fox and Montkeila streets True bearings spike on near end of pavilion on reserve, 300 feet (91 meters), 102° 21′.7; top of nearest girder at end of bridge, 1,500 feet (457 meters), 246° 09′.3, center of gate, corner of Fox and Montkeila streets, 320° 41′.7; small spire over church, one-half mile (0.8 kilometer), 329° 21′ 6

Wallaroo, South Australia, 1911 —On south side of town in South Park Reserve, 341 feet (103 9 meters) west of road which divides park into two portions, 370 feet (112.8 meters) south of boundary fence on north, about 3,000 feet (914 meters) from town hall, and about 1,250 feet (381 meters) northwest of jail; marked by jarrah peg 3 by 3 by 20 inches (8 by 8 by 51 cm.), set

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Wallaroo, South Australia, 1911—continued. with top a little below ground. True bearings: nearest spire of church, 460 meters, 237° 22′.0; steeple and flagpole of town hall, 248° 24′.3, most northerly chimney of jail, 316° 59′.0; pillar in stone wall of cemetery, 400 meters, 358° 33′ 6

Wanaaring, New South Wales, 1913 —In yard of hotel, on opposite side of street from post office.

Warrnambool, Victoria, 1912 —In small public reserve next to lighthouse, 126 feet (38 4 meters) south from Merri Street fence, 337 feet (102.7 meters) from corner fence post, where fence around lighthouse meets Merri Street fence at point in line with west line of Kelp Street, probably about one-fourth mile (0 4 kilometer) west of Neumayer's station, marked by wooden peg sunk just below surface True bearings· bottom of lamp post on eastward end of pier, 16° 44′ 6; near gable end of freight shed on pier, 26° 27′.3; center bottom right chimney of meat works, 78° 37′.5; center bottom Gordon memorial obelisk, 113° 31′ 8; flagstaff over Anglican church tower, 151° 26′ 8; top of Catholic church spire, 169° 12′.2, center top of upper lighthouse, 289° 01′ 9; center top of lower lighthouse, 325° 38′ 0 Declination observations were also made at secondary station 13 yards from main station in direction of lamp post on the eastward end of pier.

Water's Homestead, Victoria, 1913 —On Upper Yarra track from Warburton to Matlock, 16 miles (26 kilometers) from Matlock, 24 miles (39 kilometers) from McVeigh's Hotel on Yarra River, near accommodation house owned by Mr Waters, 24 feet (7 3 meters) west of paddock fence; marked by wooden peg sunk flush with ground. True bearings: top left edge southwest corner post of cleared paddock, 182 feet (55.5 meters) 326° 12′.5; top right edge northwest corner fence post of cleared paddock, 115 5 feet (35 21 meters) 172° 37′.7; right end gable of homestead, 222° 58′.6

Weipa Mission, Queensland, 1913 —On slope northeast of misson buildings and south of cultivated paddock, 154 5 feet (47.09 meters) from southwest corner of paddock, and 77.5 feet (23.62 meters) from south fence of paddock; marked by round bloodwood post sunk below ground True bearings· near gable end of mission house, 800 feet (244 meters), 43° 58′.7, center of church door, 600 feet (183 meters), 51° 37′ 9, southwest corner of cultivated paddock, 145° 06′.5.

Werris Creek, New South Wales, 1913 —East of railway station, on north end of long hill, in open ground belonging to Messrs. Doyle Brothers, 239 feet (72.8 meters) southeast of southeast corner of school grounds. True bearings: near gable end of railway signal house, three-fourths mile (1.2 kilometers), 59° 53′.4; near gable end of railway workshops, one-half mile (0 8 kilometer), 85° 47′.0; east gable end of school building, 400 feet (122 meters), 128° 04′ 0; fence post at southeast corner of school grounds, 147° 35′.3; fence post at northeast corner of school grounds, 500 feet (152 meters), 164° 02′.1.

White Wells, South Australia, 1911 —East of main road and 72 paces east of station hut, marked by holders of White Wells station, which is westernmost sub-station of G. W. Murray's Fowler's Bay station, as a place for testing compasses

Wilcannia, New South Wales, 1913.—In Burke Park, 73 feet (22 2 meters) from Myers Street fence and 165 feet (50 3 meters) from post at corner of Myers and Hood streets; marked by hardwood peg sunk just below surface of ground True bearings· center of bottom of spike over Presbyterian church belfry, one-

AUSTRALASIA.

AUSTRALIA—*continued*

Wilcannia, New South Wales, 1913—continued eighth mile (0.2 kilometer), 283° 06′.9; center of east corner fence post, 288° 22′.7; cross on near end of Anglican church, 270 feet (82 meters), 314° 36′.5 Auxiliary station 1 was 150 paces 146°.1 west of south from main station

Windorah, Queensland, 1913.—In police reserve bounded by Edward, Victoria, Maryborough, and Lewis streets, 304 feet (92.7 meters) from south corner; marked by hardwood peg sunk just below ground True bearings: near gable end of Western Star Hotel, 1,000 feet (305 meters), 95° 18′.3, west corner post of police reserve, 450 feet (137 meters), 103° 54′.1; south corner of police reserve, 340° 54′.6.

Winnecke's, Northern Territory, 1912.—At Nine-Mile Rock Hole from Winnecke's; on rise on opposite side of creek from point where road from Winnecke's meets the creek.

Winton, Queensland, 1913—In southwest corner of sports ground reserve, north of Elderslie Street, 135 feet (41.1 meters) northeast of southwest corner survey peg of sports reserve, and 71 feet (21.6 meters) from south boundary fence of reserve, marked by small stake sunk below ground. True bearings. southwest corner peg of reserve, 66° 42′.5, center of cross on church, three-fourths mile (1.2 kilometers), 117° 10′.2, right ornament on convent, three-fourths mile (1.2 kilometers), 126° 45′.9; southeast corner of sports reserve, two-thirds mile (1.1 kilometers), 279° 51′.0.

Woodgate's Swamp, South Australia, 1912—On sandhill near Woodgate's Swamp, about 80 paces east of road. True bearing: cairn on top of hill, 15° 50′.2.

Woolgoolga, New South Wales, 1913.—In southernmost of two paddocks behind Sea View Hotel, 121 feet (36.9 meters) from south fence of paddock. True bearings: southwest corner post of paddock, 300 feet (91 meters), 77° 02′.8; bottom of flagstaff of Sea View Hotel, 750 feet (229 meters), 234° 17′.6; southeast corner post of paddock, 450 feet (137 meters), 291° 30′.4.

Woomelang, Victoria, 1911.—In small paddock containing a number of scattered trees, opposite railway station and owned by government, 162 feet (49.4 meters) from fence bounding railway line and 151 feet (46.0 meters) from fence bounding inclosure containing dam; marked by wooden peg projecting 2 inches (5 cm.) above ground. True bearings. top of northernmost semaphore, 160° 27′.1; prominent chimney beyond railway station, 234° 51′.4; ledge of railway tank, 296° 09′.0; chimney of pump-house at dam, 320° 02′.8.

Wycliffe Well, Northern Territory, 1912.—About 8 miles (13 kilometers) along the road north of Wycliffe Well and about 60 yards (55 meters) west of telegraph line.

Yalata Head Station, South Australia, 1911.—In line with eastern edge of station house and 289.5 feet (88.24 meters) from corner of garden wall on same line; marked by small tent peg driven in ground. True bearings: left gable end of wool shed, 109° 56′.8; right edge of station house, 161° 49′.5; right edge of ruins, 221° 31′.6.

Yalgoo, Western Australia, 1912—In recreation grounds, 182 feet (55.5 meters) from south corner and 150 feet (45.7 meters) from southwest fence; marked by short jarrah peg set below surface True bearings: post at south corner of grounds, 6° 32′.5; flagpole of hall, 50° 52′.9

AUSTRALASIA.

AUSTRALIA—*concluded*

Yunta, South Australia, 1911.—In flat open paddock belonging to government and leased for grazing purposes, about 500 feet (152 meters) southeast of railway buildings, 352 feet (107.3 meters) from railway track, 160 feet (48.8 meters) from post-and-wire fence inclosing paddock, and about 650 feet (198 meters) from Yunta Hotel; marked by hardwood peg sunk just below surface of ground True bearings semaphore signal post, distant 900 meters, 64° 28′.6; southeast corner of Yunta Hotel, 161° 10′.6; west gable of railway freight shed, 177° 17′.8

NEW ZEALAND.

Nelson, A, 1912—This is an approximate reoccupation of Mount Street station of New Zealand Magnetic Survey of 1899 and 1903, 10.6 feet (3.23 meters) east of east line of Mount Street, 528 feet (160.9 meters) east of corner of Mount and North Esk streets, 22 feet (6.7 meters) southwest of wire fence, and 72.6 feet (22.13 meters) southwest of house and sheet-iron fence True bearing: center of front of men's asylum, 355° 37′.9.

Nelson, B, 1912—This is an approximate reoccupation of the Haulashore station of the New Zealand Magnetic Survey of 1899 and 1903, 79.2 feet (24.14 meters) from triangulation station on Haulashore Island, and approximately in line between triangulation station and south end of pilot station True bearings beacon at Tahuna, 33° 14′.0, top of lighthouse, 202° 40′.0; south edge of pilot station, 256° 39′.1, top of leading light post in old entrance, 348° 32′.0

EUROPE

BULGARIA

Burghas, 1911—On east side of road which runs north from town of Burghas, in field opposite old Moslem cemetery, and about 300 yards (274 meters) north of Christian cemetery; on small artificial plateau south of road passing through field from main road to vineyard on east, 39 paces from center of road, 33 paces from southeast corner of large pit, and 57 paces southeast from northeast corner of large pit; marked by peg driven flush with ground True bearings: dome of Bulgarian church in Burghas, 343° 02′.0; minaret in Burghas, 347° 21′.6

Nova-Zagora, 1911—In meadow on north edge of town and on east side of road which runs north from railroad station; near east end of ditch which divides meadow from cultivated land on north, 222 paces north of square concrete building, 217 paces northnortheast from door of frame building on west side of road, and 193 paces east of the 1-kilometer stone, marked by oak peg driven flush with ground True bearings. flagpole on south gable end of frame building on opposite side of road, 63° 00′.0, cross on church, 358° 54′.6

Philippopolis, 1911—In southern part of drill ground east of Philippopolis, in line with hedge bordering stable grounds on west, 49.0 meters north of end of hedge, and 48.8 meters northwest of west end of hedge bordering stable grounds on north; marked by tent peg driven flush with ground. True bearings: tall minaret in Philippopolis, 96° 45′.8, clock tower on military barracks, 77° 51′.4

Sofia, 1911.—On ridge which lies between Sofia and large mountain to southward, in meadow on north side of branch road leaving main road near three farmhouses and granite double cross and running eastward

EUROPE.

BULGARIA—*concluded.*

Sofia, 1911—continued.
to farmhouse several hundred meters from main road; 125 meters east of most easterly of the three farmhouses, 65 meters southwest of more westerly of two oak trees on roadside, and 13.9 meters from middle one of three oak trees on south side of road; marked by tent peg driven flush with ground. True bearings: tower of church in Sofia, 195° 38′.8; dome on church in Sofia, 196° 16′ 4; cross on church, about one-third kilometer, 248° 33′.2.

CRETE.

Candia, 1911.—In northeast corner of olive grove on terrace rising several feet above surrounding fields, about 200 meters southwest from wall surrounding cemetery and church of St. Constantine, 2 meters south of north edge of terrace, 5 meters northwest of olive tree at northeast corner of terrace, 45 meters northeast of northwest corner of stone house, and 45 meters northwest of northeast corner; marked by tent peg driven flush with ground True bearings: dome on St Minas Church in Candia, 159° 16′.7; tall yellow minaret in Candia, 174° 24′.6, cross on St Constantine Church dome, 223° 27′ 3

GREAT BRITAIN

Falmouth, England, 1913.—Three stations, designated *A*, *B*, and *C*, were occupied in 1913, *A* and *B* being reoccupations of 1909 stations. Main station *A* is on flat forming Trefusis Point, 11 meters from edge of bush on bank, 41.6 meters from southeast post of football goal, and 37 6 meters from northwest post of goal; marked by cross in top of Oregon pine post sunk flush with ground. True bearings. sharp church spire on hilltop, 43° 29′ 3; center of St. Anthony Lighthouse tower, 308° 50′ 0; main flagpole on Pendennis Castle, 339° 52′.1. *B* is 20 15 meters northwest of *A*, on azimuth line produced from St. Anthony Lighthouse tower, and 29.0 meters from northwest post of football goal *C* is 28.40 meters northeast of *A*, on azimuth line produced from church spire on hilltop

Falmouth Observatory, England, 1913 —Observations were made at Falmouth Observatory on brick pier in the hut used for absolute observations, and used in 1909 by Carnegie Institution of Washington A stone set up on opposite hillside was used as mark. This is permanent reference mark of observatory and is in true bearing 4° 40′ 7.

Porthallow, England, 1913.—Practically a reoccupation of station of the British Magnetic Survey of 1890, in cultivated field just south of Roskorwell farmhouse on east side of St Keverne Road; 21 9 meters from stone boundary fence on west, 40.5 meters from east fence, and 40.5 meters from north fence True bearings: St Keverne Church spire, 5° 54′.6; extreme west edge of north chimney on house distant about 50 yards (46 meters), 22° 19′.2; extreme east gable of row of quarry workmen's houses on hill, 315° 04′.4.

St Anthony, England, 1913 —Practically a reoccupation of C.I.W. station of 1909; in southwest part of field belonging to Mr. Spry, southwest of government signal station, southeast of fort on St. Anthony's Point, 4.2 meters east of brow of hill, and 39 5 meters southeast of fence post from which fence begins to make sudden dip towards water, next post west being near granite landmark on side of steep slope; not marked. True bearing. flagstaff on dome seen in direction of Pendennis Castle, 102° 53′.5.

Truro, England, 1913.—Practically a reoccupation of station of British Magnetic Survey of 1890, in east corner

EUROPE.

GREAT BRITAIN—*concluded*

Truro, England, 1913—continued.
of cricket and football field leased by Wesleyan College from Mr. Auckin, owner of Langbessow Farm, in St. Clements Rural; 25 4 meters from gate in east corner of field, 45 paces from most easterly goal post, 6 meters from ditch along southeast side of field, and 4 1 meters from boundary line along southeast side of playing field, marked by cross in top of tent peg driven flush with ground. True bearing: point on right end of red and white striped pavilion, 250 yards (229 meters), 90° 31′.9.

GREECE

Athens, 1911 —Two stations, designated *P* and *T*, were occupied. *P* is stone pier about 12 meters east of southeast corner of magnetic observatory building and used at National Observatory for magnetic observations. True bearing: cross on middle one of three towers visible on St. George Church in Lycobette, 247° 47′ 8. *T* is in walk leading up to main observatory building, about 25 meters south of observing pier, 12 8 meters west of bolt in center of gateway entrance to main observatory building, and 19 7 meters northwest of cock in cement water tank True bearings: tallest of wireless telegraph poles, 49° 51′ 9; cross on largest of three domes on St. Constantine Church in Athens, 208° 17′.5

Corfu, 1911.—At extreme west end of Vido Island, on bluff overlooking harbor; 38 meters east of more southerly of two knolls (north of ruins of old battery), 17 meters south of granite ledge at east end of north knoll, 13 5 meters north of large stone on edge of bluff, and 18 and 19 5 meters northeast and southeast respectively from southerly and northerly of four stones embedded in the mound which extends from bluff to north knoll (on this knoll there is a stone with a triangle and letters WD cut in top); marked by white marble post 10 by 10 by 40 cm. set about 30 cm. in ground and lettered C I.1911, the period after C indicating exact point True bearings: cross on lighthouse on citadel, 332° 58′ 4; tower of San Spiriton Church in Corfu, 346° 09′.4

Kephisia, 1911.—East of Kephisia, at place called Kephalari, where National Observatory of Athens has made magnetic observations, about 200 meters south of water-works, 135 meters east of stone culvert which spans ditch near corner of grove, and 13 5 meters northwest of more northerly of two small pines near road; marked by marble slab 5 by 11 by 47 cm. projecting about 4 cm. above ground and lettered C.I. 1911, the period after C being point used as station. True bearings: weather vane on red pyramidal cupola on brownstone house, 350 meters, 117° 05′ 4; smokestack of water-works, 185° 21′ 6

Patras, 1911.—In field inclosed by olive hedge on north, west, and south sides, east of Patras and southeast of brick and tile kiln, 5.5 meters southwest, 5 5 meters southeast, and 63 5 meters southeast, respectively, from fourth, fifth, and tenth trees in row along ditch; marked by tent peg driven flush with ground. True bearings: spire on lighthouse, about 0 6 kilometer, 91° 21′.2; lightning rod on smokestack of brewery, 2 kilometers, 170° 15′ 4.

Zante, 1911 —On hill called Strouza, west of Zante and near south end of large Greek cemetery; 26 2 meters southeast of southeast corner of cemetery wall and 5 5 meters west-northwest of edge of cut through which road passes; marked by tent peg driven flush with ground. True bearings: cross on tower of St. Theonisis Church, 225° 40′.1; cross on tower of St Theotokos Phoneomenis Church, 238° 48′.0.

EUROPE

ITALY.

Messina, Sicily, 1913.—In an olive grove on hill known as Monte degli Olivi, in grounds of Villa Guelfonia and due north of dwelling, 36 meters north of terrace wall running parallel with north side of dwelling, 3.2 meters northwest, 4.0 meters southwest, and 8.7 meters about east, respectively, from olive trees; marked by cross cut in top of limestone post 4 by 6 by 28 inches (10 by 15 by 71 cm.) set with top 2 inches (5 cm.) above ground. True bearings: electric wire support on Fort Gonzaga, 44° 13'.7; tip of tower on Fort Castellacio, 81° 41'.1; spire on Mont' Alto Church, 355° 04'.9.

Palermo, Sicily, 1911, 1913.—At Bocca del Falco, a suburb west of Palermo, in grounds known as Chinsa del Bosco, owned by government and leased to private individuals, near road which runs through grounds; 57 paces southwest of almond tree, 26 paces northeast of lone olive tree, and 14 paces southeast of concrete drain on northwest side of road; marked by tent peg driven flush with ground. True bearings: semaphore on Monte Gallo, 179° 15'.0; semaphore on Monte Pellegrino, 211° 10'.7.

Rome, Rome, 1911, 1913.—Stations of 1911 and 1913 are practically identical. The 1913 station is north of Rome in meadow south of house at No. 48 Via della Camilluccia, a villa named Crescin Bene; 125 paces south-southeast from center of stone wall at south end of house and is in line with fig and pear tree, which are the last two trees in row of four old fruit trees, 33.9 meters from pear tree and 16.8 meters from fig tree; marked by tent peg driven flush with ground. True bearings: lightning rod on yellow building, 66° 07'.8; cross on Church of San Joacchino, 349° 22'.1; angel on Castel St. Angelo, 349° 49'.7.

Terracina, 1911, 1913.—Two stations, designated *A* and *B*, were occupied on rifle range southwest of Terracina. *A* is 64.5 meters east-northeast of northeast corner of target pit and 64.5 meters northeast of center of top step of flight leading into target pit at its northwest end. True bearing: semaphore on Cape Circello, 67° 25'.3. *B* is 47 meters south-southwest of *A*, 18 meters north-northeast of northeast corner of target pit and 20.5 meters northeast of center of top step of flight leading into target pit at northwest corner; marked by tent peg driven flush with ground. True bearings. semaphore on Cape Circello, 67° 34'.4; cone-topped tower on hospital in Terracina, 227° 09'.6.

MALTA.

Valetta, 1911.—Nine kilometers west of Valetta, about 1,000 meters southeast of railroad station at Citta Vecchia, and about 600 meters south of railroad, in cultivated field belonging to Philip Cassar, on road from Citta Vecchia to Segieni; about 150 meters east of Philip Cassar's farmhouse, 7 3 meters west-northwest from center of well culvert, 14 5 meters northwest of large double olive tree, 10.7 meters northwest of middle olive tree, and 6.7 meters north-northwest from most westerly of three olive trees; marked by wooden peg driven flush with ground. The point is near station of Moureaux of 1887. True bearings: flagpole on Dr. Portelli's house, 66° 25'.2; tip of tower on San Agostino Convent, 132° 10' 6; cross on dome of Rabato Cathedral, 149° 54'.6.

SERBIA.

Nissa, 1911 —In meadow southeast of Nissa, not far from brick-yard, and about 175 paces south of brick-kiln; 32.5 meters north-northeast of corner of hedge around lone brick house south of road, 40 meters west-northwest of southwest corner of brick-yard, and 59 meters northwest of corner of hedge near roadside, marked by tent peg driven flush with ground True bearings: cross on center dome of large square white church in Nissa, 131° 08'.5; more easterly of two minarets in Nissa, 142° 57'.2; lightning rod on brick-kiln smoke-stack, 185° 44'.6.

SPAIN.

San Roque, Sevilla, 1912 —On farm of Mr Richard Louis Sprague, American consul, about 1.2 kilometers south of San Roque village, on southwest quarter of level circular plot about 150 meters north of farmhouse; 13.0 meters south-southeast of lone cedar, and 16.7 meters northeast of large lone fig tree; marked by block of granite about 10 by 10 by 40 cm. set flush with ground and covered with earth. True bearings: wooden cross set in round masonry column on brow of hill, 161° 24'.9; wireless telegraph pole on rock of Gibraltar, 329° 09'.7.

TURKISH EMPIRE.

Dede-Agach, 1911.—In park of café of Andonis Karamalis, about 250 meters southwest of lighthouse, 56 5 meters east of center of bottom step of café, 51.2 meters south-southwest from entrance to park, 38.5 meters east-northeast from large oak near edge of bluff, and 39 0 meters east-southeast of large oak in front of café; marked by tent peg driven flush with ground True bearings. minaret, 192° 39'.8, lighthouse spire, 238° 52' 0.

Drama, 1911.—East of Drama, on plain used as threshing ground, between Drama and suburb called Courliva, about 300 meters south of old Roman aqueduct and Turkish fountain; 88.2 meters east-southeast of southeast corner of partially constructed stone building, and 39.5 meters east of northeast corner of Moslem cemetery; marked by tent peg driven flush with ground. True bearings: lone minaret, 22° 22'.0; minaret of mosque, about 300 meters, 81° 16'.6.

Mitrovitsa, 1911.—Northeast of Mitrovitsa, in meadow on west bank of small stream running northward and bordering Mitrovitsa on east; about 350 paces north of bridge across stream, 185 paces from most northerly house in group to southwest, 32 paces west of edge of stream, and 58 paces east of cultivated field. True bearings: dome partially obscured by tall tree, 50° 54'.2; most northerly minaret visible in Mitrovitsa 58° 07'.0.

Monastir, 1911.—Southeast of Monastir, in meadow on west side of south fork of road which branches near railway station, about three-fourths mile (1.2 kilometers) south of railway station, 72 6 meters south-west of small ruined brick house, 27.0 meters west of double tree in row of four on east side of road, 20 meters east of west corner of meadow and about one-fourth mile (0.4 kilometer) west of leather factory; marked by tent peg driven flush with ground True bearings: cross on belfry of Greek church, 167° 54'.2, tall white minaret in Monastir, 169° 26'.1.

Rumeli Hissar, Constantinople, 1911 —On the heights above Rumeli Hissar, near Armenian cemetery and west of Robert College, on small bluff at west edge of meadow land, 21.5 meters east of northeast corner of most southeasterly of group of five white marble tombs inside the cemetery, 11 6 meters east of center of ditch where it makes a bend, 17 3 meters southeast of center of cross on marble slab over grave, and 17 5 meters south of center of cross on marble slab over

EUROPE.

TURKISH EMPIRE—*concluded.*

Rumeli Hissar, Constantinople, 1911—continued. grave; marked by drill hole in top of marble column 19 cm. in diameter and 57 cm. long, set flush with ground. True bearings: lone tower, 96° 26′.5, cupola on large white building with tower on opposite side of Bosphorus, 230° 34′.9.

Salonica, Macedonia, 1911.—Northwest of Salonica, about 300 meters northeast of Bulgarian cemetery and about in line with crosses surmounting tomb in main walk and chapel in French cemetery to eastward; 3 meters west of bank of small ravine, 98 meters west of entrance to French cemetery; marked by tent peg driven flush with ground. True bearings: cross on tomb in middle of cemetery walk, 272° 22′.9; tall lone white minaret, 312° 50′.7; tall white minaret seen to one side of cone-shaped tree, 315° 21′.5.

Uskub, 1911.—In meadow northeast of Uskub, near ruins of mosque, 51.7 meters north of north corner of mosque, 24 meters north of north corner of ditch surrounding mosque grounds, and 82 meters northwest of ruined brick minaret; marked by tent peg driven flush with ground. True bearings: center minaret in Uskub, 12° 55′.4; southwest minaret in Uskub, 27° 37′.8; northeast minaret in Uskub, 354° 27′ 9.

NORTH AMERICA.

CANADA.

Attawapiskat, Ontario, 1913.—On north bank of Attawapiskat River, near buildings of Hudson's Bay Company's post, about 6 miles (10 kilometers) from mouth of river and several hundred feet upstream from French trading company's buildings; 114.1 feet (34.78 meters) from nearest corner of Hudson's Bay Company's sales shop, 80.3 feet (24 47 meters) from near corner of dwelling, and 196.8 feet (59.98 meters) from flagpole True bearings: flagpole, 70° 41′; near corner of Hudson's Bay Company's store, 101° 29′; near corner of dwelling, 201° 09′; cross of church steeple, 229° 05′; flagpole of Catholic mission, 229° 34′; Hudson's Bay Company's flagpole, 233° 20′.6.

Birch Lake, Ontario, 1913.—About 1 mile (1.6 kilometers) up lake from portage from Clear Lake, on south point of island distinguished by peculiar rock shelf on its east side about 100 feet (30 meters) long, 12 to 20 feet (4 to 6 meters) wide, and 5 feet (1.5 meters) above water line, about 9 feet (3 meters) from edge of small rock shelf about 20 to 30 feet (6 to 9 meters) across, rising from water to an elevation of 3.5 feet (1 meter).

Cape Henrietta Maria Island, Ontario, 1913.—On east end of main island, a few miles west of Cape Henrietta Maria, 2.26 miles (3.64 kilometers) southeast of tripod signal. True bearing: tripod signal, 124° 29′.4.

Cat Lake, Ontario, 1913 —On north shore of Cat Lake, northeast of Hudson's Bay Company's outpost building, about 135 feet (41 meters) from water's edge, and 69 feet (21 meters) from stockade; marked by spruce post 8 inches (20 cm.) square projecting 2 feet (61 cm.) above ground. True bearings· west point of Canoe Strait, 2° 46′, east corner of Hudson's Bay Company's stockade, 6° 30′, east corner of Hudson's Bay Company's store, 13° 05′; west corner of Hudson's Bay Company's store, 28° 45′, main flagpole, Hudson's Bay Company, 43° 05′, west gable of Hudson's Bay Company's dwelling, 70° 20′; east point of Canoe Strait, 347° 40′.

Chipie River (Ghost River), Ontario, 1913 —On south bank of Albany River, opposite Chipie Island, 185 yards (169 meters) east of mouth of Chipie River, on clearing of Hudson's Bay Company's Ghost River winter post, 127.7 feet (38.93 meters) northeast of northeast corner of store, 15 feet (4.6 meters) from edge of river bank, and about 25 feet (8 meters) above river. True bearings· nearest corner of warehouse, 28° 51′.5; gable of dwelling, 41° 30′ 3; west end of island, 94° 18′; east end of island, 199° 25′.

NORTH AMERICA.

CANADA—*continued.*

Fawcett's Post, Ontario, 1913.—Reoccupation of station established by E. Fawcett in 1885, on rocky point about 10 feet (3 meters) above lake level, at south angle between Lake St. Joseph and beginning of one of rapids that form entrance to Albany River, marked by post 8 inches (20 cm.) square projecting about 4 feet (1.2 meters) out of ground, and supported by pile of stones.

Fawn-Severn, Ontario, 1913.—On point of land between Severn and Fawn rivers, south of Severn and west of Fawn, and about 7 feet (2 meters) above water. True bearings· east end of Bear Island in Severn River, 187° 50′; point of land on opposite bank, between the two rivers, 210° 15′.

Fishing Creek, Ontario, 1913 —On north bank of Albany River, opposite west end of Fishing Creek Island, northeast of Wiskakoming Island, 60 feet (18 meters) from water, and 8 feet (2 4 meters) above low water mark. True bearings: east end of Fishing Creek Island, 50° 57′; west end of Fishing Creek Island, 57° 38′

Fort Albany, Ontario, 1913.—In large field between Hudson's Bay Company's buildings and Catholic mission, near mouth of Albany River, 267.1 feet (81.41 meters) from southwest corner of church entrance hall, 228.4 feet (69.62 meters) from northeast corner of Hudson's Bay Company's cemetery, 273.7 feet (83.43 meters) from southeast corner of powder-house, 373 6 feet (113.88 meters) from mission flagpole, and in range with southeast corner of Catholic hospital and southwest corner of church entrance hall; marked by post 5 by 5 inches (13 by 13 cm.) projecting 2 feet (61 cm.) out of ground, painted red and marked by cut letters and figures of date True bearings· Hudson's Bay Company's flagpole, 597.3 feet (182 06 meters), 41° 54′.0, north gable of factor's house, 57° 19′.0; southeast corner of powder-house, 140° 14′.1, outermost casing at southwest corner of Catholic church, 257° 31′ 0, northeast corner of mission, 269° 44′.7; southwest corner of mission, 278° 13′.2, base of flagpole at mission, 292° 17′.7.

Fort Hope, Ontario, 1913.—On property of Hudson's Bay Company at Fort Hope; in open field north of factor's dwelling, northwest of store, 81 3 feet (24.78 meters) from north corner of stockade, and 163.4 feet (49.81 meters) from west corner of store. True bearings gable of dwelling, 3° 38′, northeast corner of stockade, 41° 34′; French company's flagpole, 123° 53′; bottom of cross on Catholic church spire, 133° 16′; northeast corner of warehouse, 301° 04′; northeast corner of store, 312° 01′; Hudson's Bay Company's flagpole 329° 31′; top of Protestant church spire, 338° 36′.

Fort Severn, Ontario, 1913.—On flat land at rear of Hudson's Bay Company's stockade; 259 7 feet (79.16 meters) and 215.1 feet (65 56 meters) respectively from north and west corners of stockade. True bearings gable of chapel about 600 yards (548 meters) up river from stockade, 41° 45′ 8; north corner of stockade, 280° 48′.7, gable of carpenter's house, 296° 17′.7; chimney of Hudson's Bay Company's dwelling, 301° 25′.2;

NORTH AMERICA

CANADA—*continued.*

Fort Severn, Ontario, 1913—continued
gable of store, 312° 50′.7; west corner of stockade, 315° 05′.2; gable of outside warehouse, 317° 51′ 2, gable of powder-house, 326° 57′ 2.

Fort William, Ontario, 1913.—Approximately a reoccupation of Canadian station of 1910; at southwest corner of Archibald and Bethune streets, 103 5 feet (31 55 meters) from center of former and 54 2 feet (16.52 meters) from center of latter, 96 5 feet (29.41 meters) north of fence surrounding old "Arena" athletic grounds, and about 140 yards (128 meters) east of Canadian Northern Railway track True bearings· southwest corner of Y M. C. A , 4° 54′, factory flagstaff, 101° 57′; schoolhouse flagstaff, 183° 40′.8; southeast corner of schoolhouse, 184° 27′ 6, school building flagpole, 320° 54′ 0

Greenwood Rapids, Ontario, 1913 —On upper Albany River, at head of heavy rapids known locally as Greenwood Rapids, near south side of open space at south end of portage, about 25 feet (8 meters) from water, and 30 feet (9 meters) southeast of portage trail.

Jekenakoshis, Ontario, 1913.—On west coast of James Bay, 250 yards (229 meters) north of mouth of Jekenakoshis River, on second gravel bar back from high-tide line, 135 feet (41.1 meters) from line of ordinary high tide, and about 1 mile (1.6 kilometers) from prominent sandbar island True bearings. north end of sandbar island, 37° 08′.7; high part of sandbar island, 41° 58′.7; south end of sandbar island, 43° 28′.7

Kakapeshe Lake, Ontario, 1913.—On prominent point of land on south shore of Kakapeshewenatakamakama Lake, the second lake after the long Windigo Portage; about 1 mile (1.6 kilometers) from mouth of Nagagewa River, 10 feet (3 meters) above water level, 65 feet (20 meters) and 80 feet (24 meters) respectively from water line east and west, and 150 yards (137 meters) from end of point.

Lac Seul, Ontario, 1913 —Reoccupation of Canadian Survey station, on level spot in Hudson's Bay Company's post; marked by post 6 inches (15 cm.) square projecting about 4 feet (1.2 meters) out of ground and marked "No. 5" on west side and "CMS No. 1" on east side. True bearings: Hudson's Bay Company's flagpole, 472.7 feet (144 08 meters), 34° 01′ 6; front gable of parsonage, 206° 36′.6; top of bell tower of mission church, 248° 26′ 0; south end of small island, at high-water mark, 284° 47′.8 This point is not many feet northeast of Fawcett's station.

Lake St. Joseph, Ontario, 1913.—On north shore of Lake St. Joseph, on south shore of small peninsula about 50 yards (46 meters) wide, about halfway between Osnaburgh House and where Root River connecting stream enters lake, also halfway between Alligator Point and two Indian houses.

Long Reach Bend, Ontario, 1913.—On north bank of Albany River, about 60 miles (97 kilometers) above The Forks, at a point where river changes its course from north of east to southeast, about opposite middle of long, narrow island, and about 40 feet (12 meters) from tree line. True bearings: west end of long island, 71° 29′; south point of Long Reach Bend Island, 95° 59′; east end of long, narrow island, 327° 00′.

Martin's Falls, Ontario, 1913.—On south bank of Albany River at Martin's Falls, on open space at west end of Hudson's Bay Company's buildings, 58 7 feet (17.89 meters) from southwest corner of garden fence, and 65 feet (19 8 meters) from northwest corner of fence. True bearings. tree line of farthest point on south shore, 88° 4; west point of large rock in river opposite station, 158° 12′; northwest corner of garden fence, 250° 14′, flagpole, 289° 40′, dwelling-house gable, 293° 32′; rod supporting ball of church spire, 295° 15′.9; southwest corner of garden fence, 306° 37′.

Mouth of Root River (Perch Rapids), Ontario, 1913 —On bushy piece of ground on south side of Root River, about 1 mile (1 6 kilometers) from mouth of river, at point known locally as Perch Rapids, 140 feet (42 7 meters) from edge of bank and 37 5 feet (9 91 meters) northeast of wooden track connecting wharf with warehouse, measured from point on track 283 feet (86.2 meters) from wharf and 296.5 feet (90.37 meters) from warehouse. The point is used for pitching a single tent, the general camping ground being on south side of track.

Naytahunga (Sandy Point), Ontario, 1913.—On west coast of James Bay, 17 miles (27 kilometers) north of Raft River (known locally as Wabishe River), 2 miles (3 kilometers) north of a sandbar island, about 1 5 miles (2 4 kilometers) north of mouth of small brook, and 40 feet (12 meters) back of high-tide mark.

Ochichoo Chooena Rapids, Ontario, 1913 —On Indian camping ground on north bank of Cat River, just above falls near entrance to Lake Opigikon, 10 to 12 feet (3 to 4 meters) above the river, 69 feet (21 meters) from water's edge, and 66.5 feet (20 3 meters) from largest overhanging birch tree at edge of water. True bearing largest rock at head of rapids, 344° 25′.7.

Opinnagau, Ontario, 1913 —On south bank of Opinnagau River, about three-fourths mile (1 2 kilometers) from its mouth, 2 5 miles (4 kilometers) down stream from Opinnagau trading post, about 35 feet (11 meters) south of high-water mark, 3 feet (1 meter) above high water, and about 250 yards (229 meters) west of channel 4 feet (1 2 meters) wide cut in mud bank to depth of river bed and running several hundred feet southward. True bearings: clump of trees in river in front of trading post, 99° 5, north end of island at mouth of river, 244° 13′, south end of island at mouth of river, 261° 56′.

Osnaburgh House, Ontario, 1913 —West of Hudson's Bay Company's post and on same ridge as church, estimated 200 feet (61 meters) south of church, 68 feet (21 meters) west of root cellar, 24 feet (7.3 meters) southeast of a trail on lower ground and 22 5 feet (6.86 meters) northwest of trail on same level; in range with root cellar and north side of storehouse at wharf True bearings drop in trail towards boathouse, 81 feet (24.7 meters), 49° 1; church steeple, 210° 1; flagpole, 271° 4; rod on steeple of Hudson's Bay Company's office, 271° 5; entrance to root cellar, 292° 8, gable of house about 1 mile (1.6 kilometers) distant, 321° 10′.4.

Ottawa, Ontario, 1913.—Observations were made on southern of two piers in magnetic hut of Dominion Astronomical Observatory, in corner of experimental farm nearest town.

Pakayapon, Ontario, 1913.—At mouth of stream emptying into Pakayapon River from west, about 300 yards (274 meters) above Payesk Rapids; on bare rock at end of point formed by north bank of small stream and west bank of Pakayapon River, 23 feet (7 meters) east of extreme end of point, 14 8 feet (4 51 meters) and 10.7 feet (3.26 meters) respectively from north and south edges of point. True bearings: nearest point of nearby island in Pakayapon River, 259°.9, point of land between the two streams, 320°.4.

NORTH AMERICA.

CANADA—*continued.*

Pakhoan Lake, Ontario, 1913.—At southwest corner of open point of land on north side of Cedar River and west shore of Pakhoan Lake, 108 feet (33 meters) west-southwest from bare knoll, and 152 feet (46 meters) from shore of lake. True bearings: east end of easternmost of twin islands, 228° 11′.4; highest point of rock on knoll, 108 feet (33 meters), 254° 20′.4.

Pettikau, Ontario, 1913.—On east bank of Fawn River, about 200 yards (183 meters) north of mouth of Pettikau River, 25 feet (8 meters) from low-water mark, and about 200 yards (183 meters) north-northeast of log house of abandoned winter post of Hudson's Bay Company on opposite side of Fawn River and in line with course of Pettikau River. True bearings: south gable of log house, 25° 18′.3, point of bend of Fawn River, west bank, 167° 25′.

Pigeon Portage, Ontario, 1913.—On Root River, about 57 feet (17.4 meters) east of the trail measured from point about 37 yards (34 meters) north of highest point of trail at south end of regular camping place.

Signal Ridge, Ontario, 1913.—On southeast shore of Hudson Bay, on grassy sand ridge about 1 mile (1.6 kilometers) south-southwest of surveyor's tripod signal, 100 yards (91 meters) from ordinary high tide, and about 6 feet (2 meters) above high tide.

Slate Falls, Ontario, 1913.—About 1 mile (1.6 kilometers) below the falls on north bank of Cat River, on first point of land west (about 200 yards, 183 meters) from an Indian log house, and about one-fourth mile (0.4 kilometer) northwest of Hudson's Bay Company's winter post situated on an island. True bearings: west end of nearest island, 7° 06′, east end of Hudson's Bay Company's island, 290° 01′; east end of nearest island, 314° 15′.

Small Otter River, Ontario, 1913.—On point of land at junction of Fawn and Small Otter rivers, 60 feet (18 meters) from Fawn River bank and 70 feet (21 meters) from Small Otter River bank, and about 150 feet (46 meters) southwest from extreme end of point.

The Forks, Ontario, 1913.—On north bank of Albany River, opposite group of islands in mouth of Kenogami River, northeast of west end of nearest island of group, and about 30 feet (9 meters) from edge of bank.

Trout Harbor Island, Ontario, 1913.—On southwest projection of large island opposite mouth of Trout River, about 40 feet (12 meters) east of high-tide line, about 250 feet (76 meters) from extreme end of projection, and 2.24 miles (3.61 kilometers) north-northwest from tripod signal on east end of island. True bearings: north point of island, 174° 12′; tripod signal, 311° 17′.5.

Trout Lake, Ontario, 1913.—East of Hudson's Bay Company's post on southeast end of island near north shore of Trout Lake, and about 12 miles (19 kilometers) from outlet of lake; 238.8 feet (72.78 meters) from flagpole, 79.4 feet (24.20 meters) east-northeast from southeast corner of stockade, 106.3 feet (32.40 meters) southeast from southeast corner of native dwelling outside stockade, and 42 feet (13 meters) from lake shore, 8 feet (2.5 meters) above lake level.

White Hill View, Ontario, 1913.—Ten feet (3 meters) above water and 6 feet (2 meters) from edge of rock ledge on north-northwest corner of island near point where system of river and lakes from Birch Lake joins the system connecting Whitestone and Cat lakes, about 1 mile (1.6 kilometers) due east of very noticeable white hill or island 100 feet (30 meters) high and covered with standing burnt timber, and about 1 mile (1.6 kilometers) west of rock face having rude moose carvings on moss.

NORTH AMERICA.

CANADA—*concluded.*

Winisk, Ontario, 1913.—Southwest of Hudson's Bay Company's post, on northwest bank of Winisk River, about 5 miles (8 kilometers) from its mouth, 21 feet (6.4 meters) from river bank, 148.5 feet (45.26 meters) from servants' dwelling, and 330 yards (302 meters) from Catholic mission church. True bearings: gable of Hudson's Bay Company's dwelling, 218° 26′; gable of near house, 221° 32′, north end of east island, 250° 13′, south end of east island, 259° 21′.

CENTRAL AMERICA.

Colon Harbor, Canal Zone, 1912.—The C.I.W. station of 1907, 1908, and 1909, was recovered as nearly as possible. True bearings: Colon Lighthouse, 252° 40′.5; north wireless pole, 255° 43′.3; south wireless pole, 256° 41′.5, flagpole, house No. 1 at Cristobal, Colon, 271° 04′.7.

Colon Harbor, B, Canal Zone, 1912.—About one-fourth mile (0.4 kilometer) south of 1907, 1908, and 1909 station (no longer available), about 100 yards (91 meters) west of boat landing in "sweet-water" inlet near schoolhouse "Numero dos," and 20 feet (6 meters) from water's edge. True bearings: Colon Lighthouse, 248° 13′.8; large black smokestack in Colon, 249° 33′.6; base of north wireless mast, 251° 39′.9; base of south wireless mast, 252° 30′.9.

UNITED STATES

Baltimore, Maryland, 1912.—Two stations, designated *A* and *B*, were occupied at Homewood, on new site of Johns Hopkins University, about 2 miles (3 kilometers) north of Washington Monument, on knoll in sharp turn of Wyman Park Drive, about 400 meters southwest of grandstands of athletic field. *A* is 183.5 feet (55.93 meters) northwest of fence at farthest point of turn in Wyman Park Drive, 116.5 feet (35.51 meters) from same fence to northwest, 112.0 feet (34.14 meters) nearly true south of stone boundary mark, and 502.6 feet (153.19 meters) from second stone nearly east of first. True bearings: eastern apex of Cedar Avenue Church roof, 59° 49′.5; cross on south end of roof of Lutheran church, 89° 14′.5; top of city water standpipe, Roland Avenue, 137° 51′.3; southernmost corner southeast grandstand 238° 49′.2, stone boundary monument (second stone), 254° 16′.0. *B* is on extension of line from cross on south end of Lutheran church through *A*, 64.77 feet (19.74 meters) eastward. True bearings: south cross on roof of Lutheran church 89° 14′.5; church steeple with cross, 99° 58′.7.

Cheltenham, Maryland, 1913.—Observations were made on pier *B* of the Cheltenham Magnetic Observatory of the United States Coast and Geodetic Survey; this is same station as that ocupied in 1908 and 1910.

Derring Harbor, Shelter Island, New York, 1913.—Station of 1910 was reoccupied. Is north stone of true meridian line established on 10-acre wooded tract located on bluff at southeast end of Derring Harbor and belonging to Prof. Charles Lane Poor, of Columbia University. The two meridian stones are granite posts, dressed 6 by 6 inches (15 by 15 cm.) on top and about 4 feet (1 meter) long, dressed portion extending about 8 inches (20 cm.) from top. Each is lettered on top "C.I.W. 1910" and has half-inch hole, drilled about 2 inches (5 cm.) deep at center, these drill holes mark precise points. The meridian line is approximately in middle part of level portion of tract, north stone being about 15 meters from edge of bluff, south stone 57.6 meters from north stone. The following distances were measured from north stone to copper nails driven in nearby trees, which form a triangle

NORTH AMERICA.

UNITED STATES—*concluded.*

Derring Harbor, Shelter Island, New York, 1913—cont about station: north oak tree, 4.65 meters, east dead twin trees, 5.64 meters; west dead tree, 4.22 meters. True bearings: tip of tower of Union Chapel, Shelter Island Heights, 94° 41′.3; middle of top of tall chimney, Greenport water works, 120° 23′.6; flagstaff at Greenport schoolhouse, 144° 18′.0; middle top of tall chimney of Greenport Hygeia Ice Co., 151° 18′.7; tip of spire of First Baptist Church, Greenport, 154° 15′.1.

Greenport, Long Island, New York, 1913.—Only station *A* of 1909 reoccupied. Two stations, *A* and *B*, were occupied in 1909 and 1910. Station *A* is identical with United States Coast and Geodetic Survey station of 1904. It is in northern part of school grounds just south of row of large maple trees; marked by marble post lettered on top "U S.C.& G.S. 1904," with hole at center marking precise point. Presbyterian church spire is in true bearing 203° 22′.2. Station *B* is 52.7 feet (16.06 meters) from station *A* in line from *A* to spire of Catholic church. Catholic church spire is in true bearing 45° 27′.4.

Washington, District of Columbia, Coleman Park, 1912.—Two stations, designated *A* and *X*, were occupied in subdivision known as Coleman Park, situated north of National Zoological Park and west of Rock Creek Park *A* is over small quartz stone in place, on hillside below north turn in driveway called Alta Vista Terrace, 137 feet (41.8 meters) from east edge of driveway, 37 feet (11.3 meters) south of path leading down hill, and 47.8 feet (14.5 meters) southwest of large chestnut tree. True bearings: *X*, 69° 49′.4; extreme left edge of Kenesaw Apartments, 303° 39′.0; dome on Ontario Apartments, 324° 54′.8; Washington Monument, 344° 08′.0. *X* is above Alta Vista Terrace, 6 feet (1.8 meters) east of gum tree, 192 feet (58.5 meters) southwest of *A*. True bearings: *A*, 249° 49′.4; southwest corner of stone barn in Rock Creek Park, 287° 01′.6; dome on Ontario Apartments, 322° 29′.4.

Washington, District of Columbia (New Site of Department of Terrestrial Magnetism), 1912.—In October, 1912, the two observing houses known as *A* and *C*, located near Ontario Apartments, on bluff southeast of National Zoological Park, were moved about 3 miles northwest to positions northeast of new office, laboratory, and shop building of the Department, located at Broad Branch Road and Chevy Chase Drive Observations for determinations of constants and comparison of instruments were continued in these houses in new location. There is one station in each house and these are designated as *A* and *C* respectively. Observations were made during eclipse of October 10, about 100 feet (30 meters) south of *A*.

SOUTH AMERICA.

ARGENTINA.

Concordia, Entre Rios, 1913.—Near Puerto de los Aguaderos, on grassy river bank probably in general neighborhood of 1912 station of Argentine Meteorological Office, 194 paces west of street leading to Puerto de los Aguaderos, 35 feet (10.7 meters) north-northwest of river bank, 70 feet (21.3 meters) south of small pond, 28 feet (8.5 meters) east-southeast from clump of bushes, and 30 feet (9.1 meters) west of small depression; marked by hole in top of round post 3 by 24 inches (8 by 61 cm) projecting 1 inch (3 cm.) above ground. True bearings: top of cupola on church, 97° 49′.3; top of flagstaff on rifle-range building Tiro Federal, 199° 08′.3; right edge of black smokestack in Salto, 250° 23′.0.

SOUTH AMERICA

ARGENTINA—*continued.*

Corrientes, Corrientes, 1913.—Approximately the 1912 station of the Argentine Meteorological Office, in Plaza San Martin; 197 feet (60.0 meters) east of fence bordering Santa Fe Street, and 301 feet (91.7 meters) south of building being erected in plaza; marked by peg projecting 1 inch (3 cm) above ground.

Formosa, Formosa, 1913.—In open field on opposite side of railway from Federal rifle range, in line with east side of street terminating at south side of field, 391 feet (119.2 meters) north-northwest of end of street, and 175 yards (160 meters) east of railway; marked by hardwood peg projecting 1 inch (3 cm) above ground True bearings: right edge of red factory chimney, 310° 04′.6; top of wireless tower, 348° 11′.0

Itati, Corrientes, 1913.—In pasture belonging to Señor Mariano Garcia, on east side of Moreno Street, 310 and 267 feet (94.5 and 81.4 meters) respectively from north and east fences, and about 50 feet (15 meters) east and north of dense growth of bushes in swamp; marked by peg projecting 1 inch (3 cm.) above ground.

Ita-Ybate, Corrientes, 1913.—In public plaza, in center of town, 301 feet and 243 feet (91.7 and 74.1 meters) respectively from north and east fences; marked by peg driven flush with ground. True bearing: pillar of church, 83° 57′.0.

Ituzaingo, Corrientes, 1913.—Approximately reoccupation of station of Argentine Meteorological Office, in center of Plaza General Mitre, in front of church, 146.5 and 95 feet (44.6 and 29.0 meters) respectively from southwest and southeast fences, and 52 feet east-northeast of tree; marked by brass screw in top of tent peg projecting 1 inch (3 cm.) above ground. True bearing: center of cross on church, 134° 37′.3.

Mercedes, Corrientes, 1913.—Approximately station of Argentine Meteorological Office of 1912, in pasture on farm of Señor Inocencio Diaz, north of dwelling-house, 141 feet (43.0 meters) east of front fence, 184 feet (56.1 meters) north of corner of fence inclosing tilled ground, 100 feet (30.5 meters) north-northwest of shrubby tree, and 59 feet (18.0 meters) south-southwest from small tree; marked by small tent peg driven flush with ground. True bearing: left edge of large water tank in town, 347° 52′.6.

Monte Caseros, Corrientes, 1913.—On municipal property on open bank of river, east of town, in line with west side of Uruguay Street, and 187 paces west from edge of river, marked by hole in top of tent peg driven flush with ground. True bearings: tip of church spire in Monte Caseros, 148° 07′.8, left spire of church in Santa Rosa, 281° 28′.2

Pilar, Cordoba, 1911, 1913.—Four stations, pier 1, pier 8, station *B*, and station *C*, were established at the Magnetic Observatory; all in line with observatory mark No. 1 (black line painted on stone pier) which is in true bearing 100° 14′.6 Pier 1, in absolute house, is 139.2 meters east of mark No. 1, and is observatory station for absolute determinations of declination and horizontal intensity. Pier 8, in absolute house, is 9.02 meters east of pier 1, and is observatory station for absolute determinations of inclination. *B* is 33.04 meters east of pier 8 in line to mark No. 1 extended, marked by pier erected by observatory authorities. *C* is 28.1 meters east of *B* in line to mark No. 1 extended; marked by pier erected by observatory authorities.

Piray, Misiones, 1913.—In extreme west end of narrow strip of cleared land on top of hill west of buildings, 112 feet (34.1 meters) southwest of fence corner, 9

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ARGENTINA—*concluded.*

Piray, Misiones, 1913—continued.
feet (2.7 meters) west of tree, and 13 feet (4.0 meters) south-southeast of precipitous edge of hill; marked by peg projecting 1 inch (3 cm.) above ground.

Posadas, Misiones, 1913.—Approximately a reoccupation of station of Argentine Meteorological Office, on grounds of Agricultural College, in lower end of cultivated field south of main building, 402 feet (122.5 meters) south of north fence, and 303 feet (92.4 meters) west of fence along north-and-south road. True bearing. steeple on cathedral in Posadas, 285° 54′.3.

Puerto Aguirre, Misiones, 1913 —On terrace of south bank of river below hotel, 136 feet (41.5 meters) west of fence, and 7 feet (2 1 meters) south from precipitous edge of river; marked by peg driven flush with ground True bearing: west gable of hotel, 281° 43′.9.

Saladas, Corrientes, 1913.—In only plot of public ground at head of small lake east of town, 49 feet (14 9 meters) east of path, 45 feet (13.7 meters) west of edge of lake, and 155 feet (47.2 meters) south-southeast from plum tree; marked by tent peg driven flush with ground.

Victoria, Buenos Aires, 1911 —Observations were made to northwest of Victoria Cemetery about 200 meters north of station of Argentine Meteorological Office

Victoria, Buenos Aires, 1913.—About 300 meters southeast of station of Argentine Meteorological Office, 242 feet (73.8 meters) southeast of wire fence marking southeast line of new street, 369 feet (112 5 meters) southwest of west corner of Victoria Cemetery, and in line with northwest side of cemetery extended; marked by copper nail in top of tent peg driven flush with ground. True bearings: left spire of church, 171° 26′.9; church spire in town, seen over cemetery, 249° 05′.0.

BOLIVIA.

Challapata, Oruro, 1912.—About one-eighth mile (0.2 kilometer) southwest of depot and one-fourth mile (0.4 kilometer) from town; 220 feet (67.1 meters) south of and in line with west side of corrugated-iron fence around railway yards, 70 feet (21.3 meters) northeast of northeast corner of mud wall inclosure, and 48 feet (14 6 meters) northeast of cement boundary marker 3 feet (0.9 meter) high; marked by cross on limestone post 1 by 3 by 10 inches (3 by 8 by 25 cm.) projecting slightly above ground. True bearings: square tower in town to front of windmill, 230° 24′.9; cathedral tower in old town, 265° 11′.2.

Guaqui, La Paz, 1912.—On pampa south of new town Guaqui and one-fifth mile (0 3 kilometer) south of railroad, in line with front of Hotel International, marked by brass tack in top of tent peg driven flush with ground. True bearings: northeast corner of post office in new town, 174° 23′.1; tip of central dome of church in old town, 1 mile (1 6 kilometers), 274° 30′.4.

Guayara Mirim, Beni, 1911.—On left bank of Mamore River, between river and path, 3.6 meters from high water line, 11 meters from low-water line, 4.6 meters from path, 9.7 meters from tree to southwest, and 13.7 meters from northeast corner of house to south It is east end of a base line established by engineers of Madeira and Mamore Railroad and is marked by tack in top of stake projecting somewhat above ground. True bearings: west stake of base line, 109° 06′.9; triangulation signal near upper end of island, 199° 39′.

SOUTH AMERICA

BOLIVIA—*concluded.*

Huarnonia, Cochabamba, 1912.—East of high railway bridge and near southeast corner of high bank or shelf through which railway cuts, 150 feet (45 7 meters) south of railway track, 10 feet (3.0 meters) from south edge of shelf, and 60 feet (18.3 meters) southwest of southwest corner of native hut, marked by wood peg projecting slightly above ground True bearing south edge of stonework on bridge, 67° 11′.7

La Paz, La Paz, 1912.—About one-fourth mile (0 4 kilometer) southeast of main plaza, on first hill southeast of Plaza de Toros, in line with Calle Frias; at center of northernmost and lowest of three terraces on top of hill; marked by triangular-shaped stone 3 5 by 5 5 by 12 inches (9 by 14 by 30 cm) with cross. True bearings: bent cross on cathedral tower, 69° 02′ 2, cathedral tower in line with Calle Frias, 116° 45′.0, highest point on Illimani, 292° 45′ 7.

Oruro, Oruro, 1912.—On pampa, 2 kilometers south of town; 54 feet (16 5 meters) west-northwest of road and about one-half kilometer west-northwest of a group of mud houses; marked by wood peg set flush with ground.

Patacamaya, La Paz, 1912.—On open pampa, 200 yards (183 meters) southwest of railway depot, about in line with southeast side of hotel extended, 550 feet (167.6 meters) distant, and 150 feet (45 7 meters) west of and in line with south side of mud corral extended; marked by wood peg set flush with ground True bearings: north tower of cathedral in old town, 108° 31′.2; south edge of depot chimney, 231° 17′ 2

Potosi, Potosi, 1912.—About one-fourth mile (0.4 kilometer) west of town, in flat open space southwest of railway yard, 300 yards (274 meters) west-southwest of railway track, in line with south side of second street south of depot, and about 100 yards (91 meters) west of old adobe building in east corner of space inclosed by rows of stones; marked by peg set flush with ground True bearings: clock tower of large cathedral in line with south side of second street south of depot, 313° 36′.3; cathedral tower seen through railway cut, 347° 16′.2.

Rio Mulato, Potosi, 1912.—About one-fourth mile (0 4 kilometer) northwest of depot and about 300 yards (274 meters) west of hotel; on east bank of small river which circles around town, 30 feet (9.1 meters) from water's edge; marked by cross in stone 10 inches (25 cm) long, tapering to top and set flush with ground. True bearings: flagpole on hotel, 295° 42′ 2; south edge of red water tank, 334° 20′.0.

Uyuni, Potosi, 1912.—About 1.5 kilometers northwest of plaza in Uyuni, in smaller angle west formed by intersection of two roads, 24 feet (7.3 meters) southwest from road running northwest, and 56 feet (17.1 meters) north of road running west, marked by brass tack in tent peg set flush with ground. True bearing. south edge of smokestack on railway shops, 294° 20′.0.

BRAZIL.

Abuná, Matto Grosso, 1911 —Near south end of railroad camp 33, about 20 meters north of high bank of Madeira River and 7.5 meters from southeast corner of engineers' house; marked by stake driven flush with ground.

Allianca, Amazonas, 1913.—On east bank of Rio Branco, 48 feet (14 6 meters) from north corner of house, and 14 feet (4 3 meters) from edge of river bank

Antonio Lemos, Para, 1911.—In open space between river and main street of town, about 40 meters from river

SOUTH AMERICA.

BRAZIL—*Continued*

Antonio Lemos, Para, 1911—continued and 61 meters from store of Señor Miranda, 14.5 meters north of railroad which runs from store to pier, 10.3 meters southwest of tree, and 19 4 meters north of tree; marked by stake driven flush with ground True bearings: base of flagpole of telegraph office, 111° 01′ 9; reference post used in survey of town site, 125° 54′.7; tip of square roof of small pavilion in front of intendencia, 333° 37′.2, lower left edge of intendencia windmill tank, 348° 46′ 0

Ayrao, Amazonas, 1913 —In eastern part of town, about 200 feet (61 meters) south of southeast corner of church in west line of church extended, and about 100 feet (30 meters) north of cemetery fence

Barcellos, Amazonas, 1913 —On west bank of Rio Negro, near main buildings of town, 28 5 feet (8.69 meters) from edge of bank, and 53.5 feet (16 31 meters) east of large almond tree. True bearing: more westerly of two pyramid ornaments over cemetery gate, 7° 13′ 7

Barranco Branco, Matto Grosso, 1913 —In pasture north of administrator's house and office, 350 feet (106.7 meters) from east boundary fence, and 362 feet (110.3 meters) from south boundary fence; marked by peg projecting 2 inches (5 cm.) above ground. True bearing: right edge of smokestack on Saladero, 23° 25′.8

Boa Vista, Amazonas, 1913 —On northwest bank of Rio Branco, on highest part of open space in front of buildings in southern part of town, about midway between river and row of buildings facing river, 109 5 feet (33 38 meters) northeast of tall lone palm tree, and 56 feet (17.1 meters) south of large prominent tree.

Camp No. 39, Matto Grosso, 1911.—In clearing between projected railroad right-of-way and house occupied by engineers, about 15 meters west from right-of-way and 30.5 meters east from engineers' house; marked by stake driven flush with ground.

Campiña, Amazonas, 1913.—On east side of Rio Branco, about 150 feet (46 meters) northwest from smaller of two houses, about 40 feet (12 meters) from river bank, and about 1 mile (1 6 kilometers) or more below high prominent hill on same side of river, marked by tent peg driven flush with ground.

Caracarahy, Amazonas, 1913.—There are several settlements with this name, but station is near settlement immediately below what appears to be round island in middle of Rio Branco; about 100 yards (91 meters) from bank, 60 feet (18.3 meters) south of wire fence, and 50 feet (15 2 meters) east of another wire fence; marked by cross in top of tent peg.

Caracol, Matto Grosso, 1911.—At railroad siding known as Caracol, camp 16, or kilometer 78; 40.6 meters south-southwest of railroad, measured from point on railroad 59.7 meters east of west end of switch; marked by stake 4 cm. square and projecting 15 cm above ground.

Corumbá, Matto Grosso, 1913.—Two stations, designated *A* and *B*, were occupied. *A* is on north bank of Paraguay River, opposite electric-light plant, about 250 yards (229 meters) upstream from large sunken iron barge, 62 feet (18.9 meters) south of large dead tree, and 84 feet (25 6 meters) from edge of river bank; marked by peg projecting 1 inch (3 cm.) above ground True bearings: right edge of black smokestack, 37° 55′.0; church spire in city, 311° 11′.3. *B* is reoccupation of station established in 1904 by Brazilian Magnetic Commission, in northeast corner of Plaza Santa Thereza, 106 feet (32 3 meters) west-southwest from center of Rua Frei Mariano, and 268 feet (81.7 meters)

SOUTH AMERICA.

BRAZIL—*continued*

Corumbá, Matto Grosso, 1913—continued south-southeast from center of Rua 13 de Junho; marked by drill hole in top of pillar True bearing. left edge of Collegio Salesiano, 10° 34′ 7.

Cucuhy, Amazonas, 1913.—On east bank of Guainia River, 118.5 feet (36 12 meters) south of southeast corner of commandant's residence, 117 feet (35.7 meters) southeast of southeast corner of lookout platform, and 34 feet (10 4 meters) northeast of large tree; marked by cross in top of tent peg driven flush with ground

Fazenda "Porre," Amazonas, 1913 —On plantation of this name, on east bank of Tacutu River, about 12 miles (20 kilometers) above mouth of Uraricoera River, about 60 feet (18 meters) east of smaller of two buildings The plantation belongs to Señor Generaldo Collaço Veras

Florianopolis, Santa Catharina, 1913 —In front of barracks, 80 feet (24 meters) east of pillar marking Brazilian Magnetic Commission station of 1904, 77 yards (70 meters) from front of barracks, 119 feet (36.3 meters) and 122 feet (37.2 meters) southeast and north-east respectively from iron electric-light poles, marked by screw in top of tent peg driven flush with ground True bearings. east spire of cathedral, 133° 54′.2; northwest corner of civil hospital, 351° 40′.4.

Gurupa, Para, 1911 —In public square between river and principal street of town, 52 35 meters west-northwest of northwest corner of post office, 23 56 meters south-west of large tree, 21.15 meters south-southwest from large tree near river, and about 15 meters from high shore line of river; marked by stake driven flush with ground. True bearings: white pillar near shore end of wharf, 32° 51′ 6; northwest corner of post office, 312° 58′ 3

Inajatuba, Amazonas, 1913.—On west bank of Rio Negro, about 5 miles (8 kilometers) below Moura, about 60 feet (18 meters) from high-water mark, and about 120 feet (37 meters) east of east corner of larger of two houses.

Itacoatiara, Amazonas, 1911.—In northwest corner of square known as "Praça 13 de Maio;" 36 68 meters east of house on west side of Traversa Libertad, 31 84 meters south of fence on north side of Rua Deodora, and 49.14 meters northwest of northwest corner of church; marked by stake driven flush with ground. True bearings: point of far gable of jail, 207° 42′.6; cross on church, 340° 36′.0

Itaquy, Rio Grande do Sul, 1913.—In field on left side of Cambahi, near its junction with the Uruguay, probably within a few hundred yards of the station occupied in 1904 by Brazilian Magnetic Commission, on municipal property 484 feet (147 5 meters) southeast from southeast corner of Deposito do Marinha, 155 feet (47.2 meters) north from front fence of field, marked by hole drilled in top of a post 7 inches (18 cm.) square. True bearings: right edge of barracks, 57° 12′.3; southeast corner of Deposito do Marinha 122° 08′.8.

Jaburu, Bahia, 1913 —Three stations, designated *A*, *B*, and *C*, were occupied on Itaparica Island west of Bahia and south of small pier at brick works, between shore and road *A* is on beach 65.2 meters south of south rail of narrow-gage railway running from brick works to pier, 4.6 meters from well-defined shore line, 6.6 meters from nearest of three cocoanut trees to northwest, and 16.6 meters east of wire fence. True bearings: dome of prominent cathedral in

SOUTH AMERICA.

BRAZIL—*continued*

Jaburu, Bahia, 1913—continued.
Bahia, 285° 40′.7; tip on San Antonio Lighthouse, 308° 10′ 8; right hand tip of white cornice on ruins, 353° 28′.4. Primary station *B* is on line from *A* to white cornice on ruins, 30 43 meters from *A*, 5.0 meters from shore line, 14.1 meters from fence on west side of road; marked by tarred post, 4 feet (1 2 meters) long, and 3 by 5 inches (8 by 13 cm.) on top, lettered C. I. W. on south, and 1913 on north side, with cross near southwest corner of top to mark precise position and set so as to project about 6 inches (15 cm.) above surface. True bearings: north edge of round tower on hill above station, 82° 42′.9; church spire north of Bahia, 247° 24′ 4; dome of prominent cathedral in Bahia, 285° 30′.8, tip on San Antonio Lighthouse, 308° 03′.1; right hand tip of white cornice on ruins, 353° 28′.4. *C* is in line with stations *A* and *B*, 32.30 meters south of *B*, 4.6 meters from the shore line, 4.85 meters and 9 57 meters from cocoanut trees to northeast and southwest respectively, and 9.72 meters from evergreen tree to southeast; marked by peg with cross cut in top. True bearings: tip on San Antonio Lighthouse, 307° 55′.1; right hand tip of white cornice on ruins, 353° 28′ 4

Manaos, II, Amazonas, 1911, 1913.—Very nearly a reoccupation of C I. W station II of 1910, 201 feet (61.3 meters) from wall of Instituto Benjamin, and 105 feet (32.0 meters) from fence about garden of former Casa Alden; marked by cross in top of tent peg driven flush with ground and covered with small stones. True bearings: largest ball ornament on theater light plant, 17° 08′.0; flagpole on nearby red and white house, 64° 53′.8, center ornament on front of Instituto Benjamin, 162° 31′.0.

Menena, Amazonas, 1913.—At settlement consisting of two houses, on south bank of Rio Negro, about 5 miles (8 kilometers) above Carvoeiro, about 60 feet (18 meters) west of house farthest from river, and about 75 feet (23 meters) southwest of second house

Monte Alegre, Para, 1911.—On beach between main business street and river, 52.3 meters northeast of steamer pier, 25.5 meters south of Casa Aurora, and 8 meters east of continuation of east side of first street (unnamed) east of street which is in line with pier; marked by stake driven flush with ground.

Murtinho, Matto Grosso, 1913.—In municipal plot of ground on southwest side of upper end of Avenida Hugo Henz, 237 feet (72.2 meters) from northwest boundary fence, and 331 feet (100.9 meters) from southwest boundary fence; marked by peg projecting 1 inch (3 cm.) above ground. True bearing: left edge of white smokestack, 123° 37′.2.

Mutum, Matto Grosso, 1911.—On left bank of Mutum River, and about 120 meters north of temporary railroad bridge spanning the river; marked by stake driven flush with ground.

Obidos, Para, 1911.—On nearly level ground between Amazon River and first business street parallel to river; 68 40 meters downstream from landing wharf and 35 62 meters from business houses fronting the river; station is covered at high water; marked by stake driven flush with ground.

Parintins, Amazonas, 1911.—Near center of town in square east of market, 33 9 meters north-northeast from northeast corner of cuartel, 38.7 meters from west corner of store, and 32.5 and 20.0 meters southeast and south-southeast respectively from two palm trees between station and river; marked by stake driven flush with ground True bearings: northwest corner of cuartel, 25° 36′ 2; church spire, 239° 17′.7.

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BRAZIL—*continued.*

Pernambuco, Pernambuco, 1913.—The United States Coast and Geodetic Survey station of 1907 was found obliterated by cutting away by ocean of shore of Isthmus of Olinda. New station is within 150 yards (137 meters) of 1907 station and about midway between cable house and Port Buraco, but slightly nearer latter, 12 feet (3.7 meters) inland from ridge along sea side of isthmus; marked by 3 large wooden tripod pegs. True bearings. center of dome of Arsenal Marinha, 6° 19′.6; cross on old monument near cable house, 16° 11′ 8; tallest yellow spire of church, 25° 48 2; red dome of Assembly Hall, 35° 59′.7; chimney of Beltrao Sugar Refinery, 158° 36′.5; Picão Lighthouse, 341° 14′.0.

Pinheiro, A, Para, 1911—The Brazilian Magnetic Commission station of 1903 and *Carnegie* station of 1910, in front of church of St. Sebastian, 69 5 meters from its southwest corner, about 100 meters in direction northeast from end of government wharf and about 10 meters from edge of steep river embankment; marked by concrete blocks 28 cm square by 4.5 cm. thick built up to a height of 76 cm On the top block there is a copper plate bearing the date of the Brazilian observations, name of observer, latitude, longitude, and magnetic elements, at the time of observation Exact point is at edge of copper plate directly over second "r" in word "Directoria," 8 9 cm. from south edge of block and 11 8 cm. from east edge True bearings: top ornament on Para water tower, 2° 48′.6; ornament on far gable of pier house, 42° 18′.4.

Porto Esperança, Matto Grosso, 1913—In pasture belonging to Señor Moreira, in line with extended lines of westerly and southerly fences of two small inclosed fields north and east of station, 485 feet (147 8 meters) south-southeast from southwest corner of north field, 425 feet (129.5 meters) from southwest corner of field to eastward, and about one-third mile (0.5 kilometer) south-southwest from Señor Moreira's store; marked by tent peg projecting 3 inches (8 cm.) above ground. True bearings: south gable on Moreira's store, 192° 03′.6; left edge of railway water tank, 231° 54′.2.

Porto Velho, Amazonas, 1911—In northern part of town, on high ground near water tank, 54.1 meters west-southwest of large discharge-pipe of tank, 17 0 meters from fence south-southeast, and 61.15 meters from middle of Boulevard Amazonas at point in line extended from discarge-pipe to station; marked by stake driven flush with ground. True bearing. discharge-pipe of water tank, 241° 55′.6.

Puerto Britannia, Parana, 1913—Two stations, designated *A* and *B*, were occupied near the house of Mr. Grobli. *A* is reoccupation of station of Argentine Meteorological Office, in fenced tract south of Mr. Gröbli's residence and north of servants' house, 100, 111, and 104 feet (30.5, 33 8, and 31.7 meters) respectively from fences south, east, and north; marked by tent peg projecting about 1 inch (3 cm.) out of ground. *B* is in partially cleared tract north of Mr Gröbli's residence, 64 and 65 paces respectively from south and east fences, marked by round peg projecting 2 inches (5 cm) out of ground. True bearing: left edge of Mr. Grobli's house, 42° 00′.3.

Rio Grande, Rio Grande do Sul, 1913.—Practically a reoccupation of Brazilian Magnetic Commission station of 1904, on low swampy ground, 67 yards (61 meters) south of south line of Rua Marechal Floriano, 52 yards (48 meters) south of center of narrow-gage railroad, and northwest of small clump of bushes;

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BRAZIL—*continued*

Rio Grande, Rio Grande do Sul, 1913—continued. marked by hole in top of tent peg driven flush with ground True bearing: center of flagstaff in grounds of captain of port, 167° 26′ 3.

San Felipe, Amazonas, 1913.—On west bank of Guainia River, south of last house of settlement, 67 feet (20.4 meters) from large tree near shed, and 127 feet (38 7 meters) west of large tree near edge of bank.

San Francisco, Amazonas, 1913.—On east bank of Rio Branco, about 150 feet (46 meters) northeast of cemetery, about 150 feet (46 meters) southwest of house, about 80 feet (24 meters) west-northwest of nearest one of three large tall trees, and about 40 feet (12 meters) from river bank; marked by cross in top of tent peg projecting about 2 inches (5 cm) above ground.

San Joaquim, Amazonas, 1913.—On south bank of river, in open space northwest of cemetery, 15 feet (4 6 meters) from edge of bank, about 60 yards (55 meters) northwest of small house north of cemetery, and about 40 yards (37 meters) northeast of northeast corner of second house in row along river.

San Marcelino, Amazonas, 1913—On south bank of Guainia River, opposite the settlement of San Marcelino, on estate of Señor A. M Bustos, about 100 yards (91 meters) east of residence, 43 feet (13 1 meters) southeast of southeast corner of large, substantial shed, and 27 feet (8.2 meters) south of south side of shed extended.

Sant Anna, Amazonas, 1913—On west bank of river, about 60 yards (55 meters) northwest from building named "Sant Anna," and about 25 feet (7 6 meters) back from river

Santa Isabel, Amazonas, 1913.—About 100 yards (91 meters) from west end of island, about 90 feet (27 meters) south of large tree near southwest corner of picket fence back of most westerly house on island.

Santa Maria, Amazonas, 1913.—On east bank of Rio Branco, about 100 feet (30 meters) south of front of house, 80 feet (24.4 meters) southeast of small bushy tree, and about 45 feet (14 meters) east of top of river bank; marked by cross in top of tent peg driven flush with ground.

Santarem, Para, 1911—Near north side of square known as "Praça Republica," about midway from east and west sides, on low elevation extending toward river; 45 paces north-northwest from lamp post, 66 5 meters west-southwest of corner of house at corner of Traversa 13 de Maio and open ground facing river, 33 3 meters from large tree standing on far side of small bay to west, and 17 meters north of path which crosses square from northeast to southwest; marked by stake driven flush with ground. True bearings: southeast corner of ornament on roof of theater, 44° 23′.2; northwest corner of hotel at water table, 234° 39′.8; cross on church, 253° 13′.7

Sao José do Norte, Rio Grande do Sul, 1913—In small depression on sandy plain at east end of Rua General Ozario, 102 yards (93 meters) south of north line of street and in range with east line of Rua Dr. Assis Brazil; marked by copper nail in top of tent peg driven flush with ground. True bearings: south steeple of cathedral, 13° 31′.7; cross on grave, distant 400 yards (366 meters), 217° 13′.8.

Taupeçaçu, Amazonas, 1913.—Near southwest corner of open space used as plaza, on south side of Rio Negro, 68.5 feet (20.9 meters) north of row of buildings, and 52 feet (15 9 meters) east of west line of street

SOUTH AMERICA.

BRAZIL—*concluded*

Umarituba, Amazonas, 1913—On savanna northeast of house of Señor Fontes, 145 feet (44.2 meters) east of northeast corner of picket fence, and 121 feet (36 9 meters) southeast of southeast side of picket fence extended

Urucurituba, Amazonas, 1911—In western part of town, in open space between river and principal street, 11 15 meters north-northeast from northeast corner of second store west of Casa Cinque at northeast end of row of four stores; marked by stake driven flush with ground.

Vassouras, Rio de Janeiro, 1913.—Two stations, designated *A* and *B*, in non-magnetic building on top of hill in observatory grounds, about one-third mile (0.5 kilometer) east of meteorological station *A* is center of large pillar 4 feet (1 2 meters) from north end of room. True bearing: brass pin in azimuth mark about 100 yards (91 meters) distant, 146° 40′ 4 *B* is center of smaller pillar in southwest corner of room True bearing left edge of white house on hill, about 1 mile (1.6 kilometers) distant, 178° 58′.8

CHILE.

Antofagasta, Antofagasta, 1912—East of town, halfway between shore and hills, 165 paces from railway track, at rejunction of two branches of path leading from head of Calle Bolivar to hills; marked by brass tack in tent peg True bearings: eastern water-works chimney, 30° 52′ 0; western water-works chimney, 31° 57′.0; cross on church, 57° 52′.3; cross on church, Plaza Colon, 124° 47′ 8; cross on cupola in cemetery, 183° 30′.8.

Arica, Tacna, 1913.—In sandy plain northeast of town, about 1 mile (1 6 kilometer) northeast of Morro de Arica, 125.7 feet (38.31 meters) southwest and 165 feet (50.3 meters) northwest respectively from west and south corners of cemetery wall; marked by brass tack in top of hardwood peg driven flush with ground. The flagpole on square tower in front of pest house, one-half mile (0 8 kilometer) distant, is in true bearing 5° 57′ 6.

Calama, Antofagasta, 1912.—About 1.5 miles (2 kilometers) south of town, in southwest corner of clearing about 200 meters west-southwest from corner of fence on east side of road; marked by brass tack in tent peg set flush with ground. True bearing: cross on church next Hotel de la Bolsa, 197° 12′.7.

Cebollar, Antofagasta, 1912.—In Borax Lake, 480 paces at right angles to railroad track from west corner of water-tank support nearest borax office True bearing. west stack of borax office, 11° 13′ 4.

Chillan. Nuble, 1913.—In grounds of the Quinta Agricola, the municipal farm, in center of field east of stables, 48 paces north of road and 70 paces east of prolongation of fence running parallel to east wall of stables, marked by brass tack in top of tent peg driven flush with ground True bearings: cross on prominent tower in Chillan, distant 1 mile (1 6 kilometers), 56° 12′.3; north tip on director's residence, 142° 26′.5.

Concepcion, Concepcion, 1913.—In pasture at east side of grounds of agricultural college, 132.5 feet (40.38 meters) west of fence along main road and 122 feet (37.19 meters) south from fence along road on north; marked by brass tack in top of tent peg driven flush with ground. West edge of middle window of lone brick building on north side of road leading to main entrance of school grounds is distant 100 yards (91 meters) in true bearing 218° 38′.0.

SOUTH AMERICA.

CHILE—*continued*

Coquimbo, Coquimbo, 1913.—In field on edge of beach southeast of town, northwest of cemetery, 124 paces northwest of northeast corner of stone wall around small two-story house, 8 paces west of small stream, and 26 paces south of beach; marked by brass tack in top of tent peg driven flush with ground. True bearings: cross on highest peak back of Coquimbo 147° 34′.4; tip of large dome in cemetery, 351° 05′.9.

Coronel, Concepcion, 1912.—Two stations, designated *A* and *B*, were occupied in vicinity of United States Coast and Geodetic Survey station of 1907. *A*, approximately same as 1907, is on sandy plain about three-fourths mile (1 2 kilometers) southeast of town, in line between slaughter-house and chimney of soap factory, about 100 meters west of sandy road leading to slaughter-house, on small flat knoll about 1 5 meters high and entirely bare of vegetation, and nearly in projected line of second street east of soap factory, marked by peg sunk below ground with empty glass bottles at side. True bearings: chimney at Lota Lighthouse, 25° 58′.7; Puchoco Lighthouse, 104° 29′ 2; chimney at soap factory, 150° 01′.2; north gable of slaughter-house, 334° 58′ 2. *B* is about 22 meters south 19° west from *A*, marked by peg. True bearings. chimney at Lota Lighthouse, 26° 00′ 0; Puchoco Lighthouse, 114° 51′ 9; chimney at soap factory, 151° 35′.8; north gable of slaughter-house, 332° 00′.4

Coronel, C, Concepcion, 1913.—Near station *B* of 1912; about three-fourths mile (1.2 kilometers) southeast of town, on sandy knoll about one-fourth mile (0 4 kilometer) east of railroad, 100 yards (91 meters) west of wagon road, about 500 yards (457 meters) from edge of town and 200 yards (183 meters) northwest of slaughter-house (red-roofed building with two chimneys); marked by wooden peg projecting about 2 inches (5 cm) above ground. True bearings. stack of Lota, right side of hill, 26° 03′ 5; smokestack on soap factory in Coronel, 151° 44′.7; north gable of slaughter-house, 332° 03′.5

Corral, Valdivia, 1913—In small clearing on promontory about 250 yards (230 meters) southwest of oil refinery, 12 paces east of path, and 12 feet (3 7 meters) north-northeast of dead tree stump; marked by brass tack in top of tent peg driven flush with ground. True bearings: tip of tower of customhouse, 21° 26′ 6; east edge of tower at steel smelter, distant 0.5 mile (0.8 kilometer), 341° 55′ 0

Curico, Curico, 1913.—In center of pasture north of penitentiary wall, in line with north edge of large buttress nearest northeast corner of wall, 134.8 feet (41 08 meters) from corner of buttress, and 250 yards (229 meters) southeast of west edge of cemetery wall; marked by brass tack in top of tent peg driven flush with ground. True bearings: west edge of cemetery wall, 147° 45′.3; cross on hill, 314° 34′.1.

Iquique, Tarapaca, 1913.—On Serrano Island, about 200 yards (183 meters) south-southeast from lighthouse, and near south edge of circular plat in center of island, marked by brass tack in top of tent peg driven flush with ground and covered by a rock 1 by 1 by 1.5 feet (30 by 30 by 45 cm) True bearings: tip of lighthouse, 167° 46′ 6; cross on cathedral in Iquique, 286° 55′ 1.

Linares, Linares, 1913.—About 2 miles (3 kilometers) northeast of town, in pasture west of town cemetery, in line with north edge of brick vaults in southwest corner of cemetery, 116 feet (35.4 meters) north of fence along road, and 52.5 feet (16 0 meters) east of small stream; marked by brass tack in top of tent peg driven flush with ground.

Loncoche, Valdivia, 1913—In pasture on west side of railroad freight yard, 60 paces west of large dead tree, 28 paces east of bend in stream just north of foot bridge, and 38 paces southeast of sharp bend in stream; marked by brass tack in top of tent peg projecting 1 inch (3 cm) above ground.

Osorno, Llanquihue, 1913.—About 3 miles (5 kilometers) east-southeast from town, in Cancha de Carreras, a private race-course belonging to Señor Reinaldo Ide, 75.5 feet (23.01 meters) from front of grandstand, measured at right angles from a point 90 feet (27 4 meters) from northwest corner of stand; marked by brass tack in top of tent peg driven flush with ground.

Puerto Montt,[1] *Llanquihue,* 1913.—In open grass plot on northeast extremity of Tenglo Island, about 100 yards (91 meters) north of two large red buoys, about 200 yards (183 meters) southeast of frame house, and 32 paces southeast of barb-wire fence inclosing the house, marked by brass tack in top of tent peg driven flush with the ground True bearings: cross on church in main plaza of town, 1 mile (1.6 kilometers), 208° 01′ 8; cleft in point of Volcano Calbuco, 238° 40′ 4.

Rancagua, O'Higgins, 1913—About one-half mile (0 8 kilometer) east of town, in center of Avenida Alameda, about opposite end of unpainted mud wall running west of house marked "Chacra San Miguel," 2 feet 2 inches (66 cm) west of line joining two blazed scrub pines and 40 feet (12 2 meters) from north tree; marked by brass tack in top of tent peg driven flush with ground

San Rosendo, Concepcion, 1913—On south side of Laja River and east of railroad, 126 feet (38.4 meters) east of fence and 63 feet (19 2 meters) from present edge of river; marked by brass tack in top of tent peg driven flush with ground True bearings: large cross on side of hill above San Rosendo, 166° 01′ 8; large white cross in cemetery, 243° 31′.2.

Santiago, Santiago, 1913.—Three stations, designated *A*, *B*, and *C*, were occupied. Main station *A* is about 50 yards (46 meters) west-southwest from southwest corner of football field, in Quinta Normal, and about same distance east of road, 10 8 feet (3.29 meters) east of line of tile drain and 13 5 feet (4 11 meters) north of line of tile drain; marked by brass tack in top of hardwood peg *B* is in unused path in northwest corner of Quinta Normal, about 50 yards (46 meters) from north wall, 25 yards (23 meters) from west boundary wall, and about 350 yards (320 meters) west of *A*; marked by brass tack in top of peg projecting about 1 inch (3 cm) above ground. *C*, the same point occupied by L. G. Schultz in 1904, is about one-half mile (0.8 kilometer) from *A* in private grounds of Señor Meneses, 3623 Calle San Pablo, at corner of Calle Andes and Calle Villesana, about 75 feet (23 meters) from galvanized-iron fence and 100 feet (30 meters) from horse-car line, this point is not suited for reoccupation.

Tacna, Tacna, 1913—About 1 mile (1.6 kilometers) northwest of town, 150 yards (137 meters) northwest of the east corner of Peruvian cemetery, and 105.7 feet (32.22 meters) northeast of the corner of offset in northeast wall and in line with gateway in offset; marked by brass tack in top of tent peg driven flush with ground True bearings. cross beside pyramid on mountain, 165° 07′ 3; edge of east corner of cemetery wall, 326° 54′ 8.

Temuco, Cautin, 1913.—In pasture of agricultural school. at northwest corner of Avenida Vicuna MacKenna and Avenida Balmaceda, 57 feet (17 4 meters) from fence

[1]There is no description for Puerto Montt (Auxiliary).

SOUTH AMERICA.

CHILE—*concluded*

Temuco, Cautin, 1913—continued.
to northwest along ditch, 76 5 feet (23.32 meters) from west line of Avenida Vicuna MacKenna, measured from point 136.75 feet (41 68 meters) north of corner of streets; marked by brass tack in top of tent peg driven flush with ground. True bearings: south edge of water tank, one-half mile (0.8 kilometer), 81° 38′ 9; west corner of stable, 100 yards (91 meters), at agricultural school, 219° 16′.1.

Valparaiso, Valparaiso, 1913.—Main station, *A*, is about 5 miles (8 kilometers) southeast of Valparaiso, between two roads out of Valparaiso which unite near Miradero O'Higgins monument, near south edge of top of very prominent ridge, about 200 yards (183 meters) northwest of O'Higgins monument and short distance south of shallow well; marked by brass tack in top of tent peg driven flush with ground. Tip of letter A on O'Higgins monument is in true bearing 341° 16′.6. A secondary station, *B*, was occupied in Park Playa Ancha about 200 feet (61 meters) in front of lighthouse. Electric-car line about one-quarter mile (0.4 kilometer) distant produced effects in observations, particularly so in inclination, which element could not be observed.

Victoria, Malleco, 1913 —In ground of Club Hipico, in line with west end of grandstand and 138 feet (42 1 meters) south of southwest corner of grandstand; marked by brass tack in top of hardwood stake driven flush with ground. True bearing: tip of church steeple in town, 1.5 miles (2.4 kilometers), 265° 03′.2

COLOMBIA.

Puerto Villamizar, Santander, 1912 —Near western end of line of houses along river, and about 10 feet (3.0 meters) from bank of river.

ECUADOR.

Esmeraldas, Esmeraldas, 1912 —South of town, in pasture of Mr. Trujillo, 160 feet (48.8 meters) west from bank of river, 37.3 feet (11.37 meters) south of small tree, 67.6 feet (20.60 meters) east of nearest tree of small clump, and about one-third of way from pasture entrance at edge of town to large galvanized-iron building; marked by brass tack in tent peg driven flush with ground. The C. I. W. station of 1908 was unsuitable for reoccupation. True bearing: spire of church, 168° 01′.9. Secondary station *A* was on sandbar at mouth of river.

GUIANA.

Apotori, British Guiana, 1913.—A reoccupation of Boundary Commission station of 1906, on site of former village of Apotori, on point of land between Essequibo and Rupununi rivers, about 18 feet (5 5 meters) northeast of two trees growing close together, and about same distance from the two rivers.

Dadanawa, British Guiana, 1913 —About 100 feet (30 meters) north of Boundary Commission's station of 1906, 150.0 feet (45.72 meters) north of house of Mr Melville, and 159.6 feet (48.65 meters) northwest of northwest corner of main part of Mr. Ogilvie's house; marked by cross in top of tent peg.

Georgetown, British Guiana, 1913.—In Botanical Gardens, about 250 yards (229 meters) north-northwest of C. I. W. station of 1908, in one of open plots of ground on south side of grounds between stand and assistant director's house, about 150 feet (46 meters) northeast of house, 40.5 feet (12.34 meters) northeast of sunshine recorder, 117 feet (35.7 meters) north of wire fence

SOUTH AMERICA.

GUIANA—*concluded.*

Georgetown, British Guiana, 1913—continued.
along south side of driveway, and 52 feet (15.8 meters) west of close hedge on north-and-south driveway leading to stand; marked by long octagonal stone post 6.8 inches (17 cm) in diameter, with rounded head projecting 18 inches (46 cm) above ground. True bearing: knob on spire of stand, 200° 09′ 0.

Rockstone, British Guiana, 1913.—A few feet west of C. I. W. station of 1908, on east bank of river, and about equally distant from southwest corner of hotel, east bank of river, and north bank of small stream emptying into river.

Sauri-Wau River, British Guiana, 1913.—Practically a reoccupation of the station established in 1906 by Boundary Commission; about 1 mile (1.6 kilometers) from mouth of Sauri-Wau River, about 200 yards (183 meters) east of house occupied by Mr. Drager, and about 70 feet (21 meters) west of nearest building.

Siparuni River Mouth, British Guiana, 1913.—Approximately a reoccupation of Boundary Commission station of 1906, on east bank of river, near buildings of balata warehouse, opposite mouth of Siparuni River, 25 feet (7 6 meters) southeast of front of center one of three sleeping sheds, and 35 feet (10.7 meters) northwest of large prominent tree; marked by cross in top of tent peg driven flush with ground.

Wismar, British Guiana, 1913.—Approximately a reoccupation of C. I. W station of 1908, on hill west of railway station south of house occupied by superintendent of railway. True bearing: flagpole 35 feet (10.7 meters) north of old gable end of steamer landing, and distant 175 yards (160 meters) from station, 264° 03′.7.

Yupukarri, British Guiana, 1913 —Practically a reoccupation of station of Boundary Commission of 1906, 103.3 feet (31.48 meters) south of new church, and 113.0 feet (34 44 meters) southeast of round part of school building.

PARAGUAY.

Bahia Negra, 1913 —On west bank of river, in line with south fence of most southerly house fronting river, 544 feet (165 8 meters) due west of southwest corner of same fence, 215 feet (65.5 meters) east-northeast of northeast corner of fence around small burying ground; marked by peg projecting 2 inches (5 cm.) above ground. True bearing: flagstaff in front of barracks, 255° 45′.8.

Cahi Puente, 1913.—In center of pasture west of railway station, 146 paces west of east fence, 195 paces north of south fence; marked by tent peg projecting 1 inch (3 cm) above ground. True bearing: left edge of railway station, 296° 11′.5

Concepción, 1913 —On waste land east of town, about one-third mile (0.5 kilometer) northeast of church, 141 feet (43.0 meters) northeast of small tree, 299 feet (91 1 meters) east-southeast from southeast corner of fence inclosing small lot, and 66 feet (20.1 meters) west of small clump of bushes; marked by peg projecting 1 inch (3 cm.) above ground. True bearing: right edge of church steeple, 50° 07′.8.

Encarnación, 1913.—In northern outskirts of town, in center of plaza called Laguna Colorado, in line with east side of street at middle of south side of plaza, 410 feet (125.0 meters) from end of same street and 95 feet (29.0 meters) southwest from orange tree; marked by tent peg projecting 1 inch (3 cm.) above ground.

SOUTH AMERICA.

PARAGUAY—*continued.*

Puerto Pinasco, 1913.—On north bank of river, 242 feet (73.8 meters) north-northwest from edge of bank, 262 feet (79.9 meters) southeast from southeast corner of native house, and eastward of group of buildings facing the river; marked by peg projecting about 3 inches (8 cm.) above ground. True bearing: left edge of smokestack, 78° 53′.1.

Sapucay, 1913.—In large field south of railway and east of group of houses, in line with south side of blind street which is most southerly street of town, 150 yards (137 meters) north of football field, and 345 feet (105.2 meters) east of end of blind street; marked by peg projecting 2 inches (5 cm.) out of ground. True bearings: left edge of railway water tank, 173° 24′.5; left edge of white house on hill, 255° 12′.5.

Trinidad (*Asuncion*), 1913.—In Trinidad, suburb of Asuncion, on top of small hill in field of Botanical Gardens, north of path leading from railway station to home of director, 113 paces north-northwest from front fence of gardens, 138 feet (42.1 meters) west of tall palm tree, and 71 feet (21.6 meters) northeast of large branching tree; marked by tent peg driven flush with ground. True bearing: right edge of railway warehouse, 321° 06′.4.

Villa del Pilar, 1913.—On bank of River Neembrucu, 60 feet (18.3 meters) southwest of small arm of river, 429 feet (130.8 meters) east of fence of schoolhouse, 244 feet (74.4 meters) north of fence around church, and about one-fifth mile (0.3 kilometer) northeast of Plaza Twelfth of October; marked by peg projecting 1 inch (3 cm.) above ground. True bearing: spire of church, 37° 04′.3.

Villa del Rosario, 1913.—On open plot of ground about one-third mile (0.5 kilometer) from dock, and on north side of road from town to dock, 170 feet (52 meters) north of large tree which is 20 paces north of road, and 101 feet (30.8 meters) east of small clump of bushes; marked by peg projecting about 1 inch (3 cm.) above ground.

Villa Rica, 1913.—Approximately a reoccupation of the station of Argentine Meteorological Office, on brow of hill, 193 feet (58 8 meters) south-southeast of southeast corner of slaughter-house, and 33 feet (10.1 meters) west of path; marked by tent peg driven flush with ground. True bearings: steeple of cathedral in town, 91° 50′.2; southeast corner of slaughter-house, 155° 26′.0.

Yaguarazapa, 1913.—On hill 140 paces due north of residence of Señor Carlos Mueller; marked by peg driven flush with ground. True bearings: west gable of Señor Mueller's house, 0° 26′.0; west gable of Señor Mayntzhusen's house, 123° 41′.1.

Yegros, 1913.—In field belonging to Señor Leopoldo Moulard, southwest of railway station, 174 feet (53 0 meters) southwest from front fence and 298 feet (88.6 meters) northwest of fence on southeast side of field; marked by tent peg projecting 1 inch (3 cm.) above ground. True bearing: right edge of railway water tank, 256° 52′.6.

PERU.

Abancay, Apurimac, 1912.—Northeast of town and east of town cemetery, in line with north wall of cemetery, and 53.8 feet (16.40 meters) east of east wall, 66.5 feet (20.27 meters) south of path in north edge of field; marked by brass tack in tent peg driven flush with ground.

SOUTH AMERICA.

PERU—*continued.*

Acobamba, Huancavelica, 1912.—Southwest of town, in center of level circular grass plot 80 feet (24.4 meters) in diameter, at top of high cultivated mound, and about 125 yards (114 meters) northeast of cemetery; marked by brass tack in tent peg driven flush with ground. True bearings: south door of sanctuary Angelpata, 126° 25′ 9; cross on mountain peak, 178° 45′ 3; east edge of house with three domes, 340° 29′.3.

Andahuaylas, Apurimac, 1912.—On south side of Andahuaylas River, in northwest corner of large alfalfa field, 50 feet (15 2 meters) east of mud wall inclosing large peach orchard, 29 feet (8.8 meters) north of large pile of rocks, 45 feet (13.7 meters) south of edge of high bank along river, and about 250 yards (229 meters) south-southeast of northeast corner of church in town on north side of river; marked by brass tack in tent peg driven flush with ground. True bearing: northeast corner of church in town, 160° 51′.2

Arequipa, Arequipa, 1912.—About 3 miles (5 kilometers) north of main plaza of Arequipa, in open space near northeast corner of grounds of Arequipa branch of Harvard Astronomical Observatory, 63 6 feet (19.39 meters) from dome for 13-inch telescope; 34.4 feet (11 58 meters) from north mud and stone wall, and 63.7 feet (19.42 meters) from wall on east side; marked by wooden stake driven flush with ground. True bearings· northwest corner of Observatory residence, 3° 09′.1; small pole on tower of large white dome of cathedral, 32° 40′.2; cross on top of Misti, 239° 36′.8; tower at Jesus' Baths, 310° 48′.4. A secondary station was placed 49.9 feet (15.21 meters) nearer northeast corner of grounds, true south 245° 15′.8 west from main station, 12.8 feet (3.90 meters) from north wall, 15.5 feet (4.66 meters) from east wall, and 15.1 feet (4 55 meters) from large willow tree to southwest; marked by wooden stake set flush with ground. True bearing: knob on tower of cathedral across valley, 336° 36′.0.

Ascope, Libertad, 1912.—About three-eighths mile (0.6 kilometer) east southeast of railway station, in northwest corner of alfalfa field, 72.8 feet (22.19 meters) from west fence, and 74.5 feet (22.71 meters) from north fence which borders main road leading from railway station and running parallel to railway and irrigation ditch; marked by brass tack in peg driven flush with ground. True bearings: southeast corner of wall, 39° 04′.0; base of cross on top of hill, 150° 32′.2; base of cross on stone building, 256° 58′.2.

Ayacucho, Ayacucho, 1912.—Southeast of town, near top of hill, in small field inclosed by cactus and century-plant hedge and forming small plateau projecting from north side of hill; about 150 meters north-northwest of mud chapel, about 25 meters northeast of round stone maize storehouse, about 80 meters northwest of mud house on hill, 16 feet (4.9 meters) east of largest century plant in hedge, and 44.5 feet (13.6 meters) north of large rock in hedge; marked by tent peg with brass nail in top True bearings: south edge of house on top of mountain, 65° 15′.6, tip of west tower of cathedral, 124° 40′.0.

Baños, Huanuco, 1912.—On south end of first island about 2 miles (3 kilometers) below Baños, in Pachitea River; 10, 50, and 20 feet (3.0, 15.2, and 6.1 meters) respectively from east, south, and west edges of island which is about 300 yards (274 meters) long by 100 yards (91 meters) wide; marked by copper nail in top of post projecting 3 feet (0.9 meter) out of ground.

SOUTH AMERICA.

PERU—*continued*

Barranca, Loreto, 1911.—In edge of clearing between river and house on San Francisco plantation, 2.2 meters from flagpole, 8.8 meters from fence to northwest, 26.5 meters from fence to southeast, and 85 meters from west post of porch of house; marked by small stake driven flush with ground.

Chala, Arequipa, 1912.—About one-eighth mile (0.2 kilometer) from boat landing, 151 feet (46.0 meters) east-southeast of southeast corner of Catholic church; marked by brass tack in top of wooden peg set 4 inches (10 cm.) below ground and covered with three small stones. True bearings: base of cross on high hill, 40° 01′.0, base of cross, 167° 54′.0.

Chiclayo, Lambayeque, 1912.—On highest part of low mound near east side of brickyard, about one-half mile (0.8 kilometer) east of more easterly plaza, 35 feet (10.7 meters) northwest of narrow road, and about 200 yards (183 meters) east of creek which is spanned by substantial bridge almost in range between plaza and magnetic station; marked by brass tack in top of peg driven flush with ground. True bearings: smokestack, 46° 00′.0; right edge of square smokestack, 77° 26′.1; middle one of three towers on large building, 91° 50′.0.

Chilete, Cajamarca, 1912.—In low rocky field, about one-eighth mile (0.2 kilometer) northwest of railway depot, south of small stream, and in line with nearest segment of curved stone wall, which is distant about 180 feet (55 meters); marked by cross on stone about 12 by 6 by 8 inches (30 by 15 by 20 cm.) projecting slightly above ground. True bearing: flagpole on railway station, 318° 12′.7.

Chimbote, Ancash, 1912.—About one-third mile (0.5 kilometer) from landing pier and one block west of fence inclosing railway grounds, in line with fronts of houses on west side of street, and 243.5 feet (74.22 meters) north of northeast corner of nearest house; marked by brass tack in top of wooden peg driven flush with ground. True bearings: cupola of distant building, 86° 00′.2; nearest corner of largest tomb in cemetery, 210° 39′.2; corner of railway-yard fence, 255° 20′.4; flagpole on railway building, 345° 58′.4.

Cuzco, Cuzco, 1912.—South of town, in southeast corner of large grass plaza in front of Church of St. Belen, 26.5 feet (8.08 meters) from mud wall to east and 32 feet (15.8 meters) from mud wall to south; marked by brass tack in top of tent peg driven flush with ground. True bearing: cross on central dome of Church de la Compania, 197° 17′.0.

Eneñas, Junin, 1912.—In center of clearing in jungle on trail from San Luis de Shuaro to Puerto Yessup, at kilometer No. 51 from San Luis, 50 yards (46 meters) south-southwest of southwest corner of shed to west of inn; marked by brass tack in top of post projecting 6 inches (15 cm.) above ground.

Hacienda Pajonal, Ayacucho, 1912.—In province Congallo on Rio Pampas, on farm of this name, belonging to Señor Parodi, northwest of residence and about 100 yards (91 meters) northeast of sugar mill, 32 feet (9.8 meters) west of brush fence, and 18 feet (5.5 meters) south of edge of field.

Honoria, Huanuco, 1912.—On south bank of Pachitea River, on line between two grass huts, 45.5 feet (13.87 meters) from hut to northeast and 72 feet (21.9 meters) from one to southwest; marked by copper nail in top of post projecting 3 feet (0.9 meter) out of ground.

SOUTH AMERICA.

PERU—*continued.*

Huacho, Lima, 1912.—About 175 yards (160 meters) west of railroad depot, 67 feet (20.4 meters) from seashore, 67 feet (20.4 meters) from northwest corner of large mound, 56 feet (17.1 meters) from middle of small knob-like mound in angle between seashore and gully; marked by brass nail in top of soft rock about 14 by 16 inches (35 by 40 cm.) set so as to project 1.5 inches (4 cm.) above ground. True bearings: distant cross on point of land, 135° 48′.4; large cross on near mound, 170° 23′.8; head of figure on church spire, 271° 48′.4.

Huancayo, Junin, 1912.—On west side of town, one block north of street leading from main plaza of town to gateway of cemetery or "Panthcon Grande;" in corner of pasture, 58 feet (17.7 meters) southwest from mud wall, 45 feet (13.7 meters) southeast from lone tree in hedge of century plants; marked by brass nail in top of tent peg projecting 1.5 inches (4 cm.) above ground. True bearings: cross on tomb in north corner of cemetery, 4° 18′.9, ball on church in valley 3 miles (5 kilometers) 66° 52′.7.

Ica, Ica, 1912.—About one-half mile (0.8 kilometer) southeast of central plaza, in soccer football field just beyond building of Alfonse Ugarte Shooting Club, 101 feet (30.8 meters) east of south end of grandstand; marked by brass tack in top of wooden peg driven flush with ground. True bearings: knob on dome, 58° 18′.7, most prominent spire to west, 117° 39′.3, cross on top of large sandhill, 137° 20′.9.

Jauja, Junin, 1912.—In grounds of shooting club of Jauja, on north side of town, on grass walk between caretaker's house and cemetery, 61 feet (18.6 meters) from circular arbor in path, 110 yards (101 meters) from shed at cemetery, 2 feet (61 cm.) from west edge of path and 4 feet (1.2 meters) from east edge; marked by brass nail in top of tent peg. True bearing: west edge of window in tower of church on hillside, 1.5 miles (2.4 kilometers), 47° 38′.7.

Juli, Puno, 1912.—About 1 mile (1.6 kilometers) north of town on shore of Lake Titicaca, 90 paces south of water's edge, in line with west wall of large mud house belonging to Facioni & Co., of Juli, 310.7 feet (94.69 meters) north-northwest of its northwest corner, 197.7 feet (60.25 meters) east of east side of large circular mud and stone seat at south end of stone pier; marked by brass tack in top of tent peg driven flush with ground. True bearings: cross on mountain top, 1 mile (1.6 kilometers), 40° 41′.1; west edge of white post with red tile top at corner of Calle Zela and road leading to Cerro Pela, two-thirds mile (1 kilometer), 342° 22′.6; cross on dome of Church de la Compania, three-fourths mile (1.2 kilometers), 359° 58′.1.

Juliaca, Puno, 1912.—In the pampa one-half mile (0.8 kilometer) southwest of town, in range with west side of ruined mud-plastered stone house, 42 feet (12.8 meters) north of its northwest corner, 66 paces from road running along west side of pampa; marked by brass tack in top of tent peg driven flush with ground and covered with stone about 1 by 1 by 2 feet (30 by 30 by 61 cm.). True bearings: cross on tower of La Merced Church, in town, one-half mile (0.8 kilometer), 223° 18′.2; cross on mud house, one-fourth mile (0.4 kilometer), 290° 34′.4.

La Fundicion, Junin, 1912.—About 10 kilometers from Cerro de Pasco, on Central Railway of Peru, at center of bare circular depression about 40 feet (12.2 meters) in diameter, near center of a large pampa at foot of mountain on which smelter is located, three-fourths mile (1.2 kilometers) northwest of smelter, two-thirds mile (1 kilometer) southwest of smelter pest-house,

SOUTH AMERICA.

PERU—*continued.*

La Fundicion, Junin, 1912—continued. one-half mile (0 8 kilometer) from electric line and trail running from pest-house, and about one-third mile (0.5 kilometer) from mountain side to southwest; marked by brass nail in top of tent peg. True bearings: tip of boundary stone, 188° 15′.6; south edge of smelter pest-house, 272° 34′.1; west edge of Hotel Tinohuaco, 351° 59′.5

La Merced, Junin, 1912—In cornfield belonging to Mayor Khalte, two streets east of main street of town, on edge of high bluff above river, 300 yards (274 meters) east of church, 200 yards (183 meters) north-northeast of building of Sociedad Filarmonica, and about 50 feet (15 meters) west of edge of bluff. True bearings: east edge of Filarmonica building, 32° 34′ 5; north edge of church, 106° 23′.5. Dip was also observed at secondary station 50 feet (15 2 meters) directly in front of Filarmonica building and 200 yards (183 meters) from main station.

Libertad, Loreto, 1911.—On right bank of Maranon River, in front of first house (going down stream) on Libertad plantation; in path leading from canoe landing to house, 10 meters from river bank, about 90 meters from northeast corner of house, and in line between two trees which are distant 3.2 meters and 3.0 meters respectively to southeast and northwest.

Lima (*Hipodromo*), *Lima,* 1912.—Inside race-course or hipodromo of Jockey Club of Lima, 2.5 kilometers southwest of palace; 379 feet (115 6 meters) from iron fence in front of grandstand, 95 feet (29.0 meters) northwest of and in line with section of stone wall probably used for hurdling, and in range between southeast corner of shed at southwest corner of race-course and wireless tower on San Cristobal Hill; marked by nail in wooden stake 4 by 4 by 18 inches (10 by 10 by 46 cm) set flush with ground. True bearings: support of crescent on top of grandstand, 159° 32′ 1; knob on small crown-shaped dome on house in Lima, seen to right of grandstand, 176° 04′ 6; center of cross on San Cristobal Hill, 214° 28′.2; wireless tower on San Cristobal Hill, center of south support, 214° 35′.2 Second station, *A*, was occupied 87 3 feet (26.61 meters) south of main station and in range with main station and knob on small crown-shaped dome.

Limatambo, Cuzco, 1912—Southeast of town, two squares southwest and two squares southeast of south corner of plaza, in small open grass plot, 15 feet (4 6 meters) northwest of edge of stream, 8 feet (2.4 meters) from edge of bank 25 feet (7.6 meters) high, at point from which line through large tree across road to northwest is perpendicular to mud wall inclosing cultivated field. True bearings: west porch of house at Hacienda Quillabamba, 200° 39′ 4, cross on top of hill, 260° 32′.9.

Masisea, Loreto, 1912—Stations of C. C. Stewart, 1910, were reoccupied as nearly as possible. Station of 1912 is on east bank of Ucayali River, near steamer landing of Tushmo, the first farm above Masisea, 14 feet (4 3 meters) north of path leading from river to house of Pedro Moreno, 160 yards (146 meters) west of farmhouse, 21 feet (6 4 meters) from edge of high bank along river, 25 feet (7 6 meters) west-southwest of large tree just north of path, and 22 5 feet (6 86 meters) west of row of trees and stumps; marked by brass tack in top of post projecting 3 feet (0.9 meter) out of ground Dip observations were also made at steamer landing of Masisea, at junction of two paths, 240 feet (73 2 meters) south-southeast of most southerly house of Masisea, 200 feet (61.0 meters) south-southwest of steamer landing, 72 feet (21.9 meters) from edge of high bank of river, 20.5 feet (6 25 meters) from path leading from hotel to town of San Pedro, and 13.5 feet (4 11 meters) from path following edge of bank and leading to San Pedro; marked by brass tack in top of stake projecting 1 foot (30 cm) above ground

Matucana, Lima, 1912.—Southwest of town, in pasture beside road, on raised ground, 80 yards (73 meters) from sanctuary which stands on roadside, 11 feet (3.4 meters) north of third stone wall from sanctuary; marked by brass nail in tent peg driven flush with ground. True bearing: east edge of sanctuary, 190° 12′.0.

Mollendo, Arequipa, 1912, 1913.—About one-half mile (0 8 kilometer) north of dock and one-eighth mile (0 2 kilometer) west of main street, in line with southeast fence of town cemetery, 75.4 feet (22.98 meters) from south corner of cemetery, and 149 9 feet (45.69 meters) northwest of stone inclosure, marked by brass tack in top of wooden peg driven below ground and covered with a stone. True bearings: cross in frame on hill, 146° 17′ 2, cross on east spire of Catholic church, 326° 09′.9, lamp of harbor light seen just above small shed, 344° 00′ 3

Oroya, Junin, 1912.—About one-quarter mile (0.4 kilometer) southwest of Cerro de Pasco Railway depot and hotel, on small level place on bluff about one-fourth way up hill; about 100 yards (91 meters) southeast of railroad tracks, 17 feet 8 inches (5.39 meters) southwest of large rock, 17 feet 4 inches (5.28 meters) northwest of large rock, and 5 5 feet (1 67 meters) from edge of bluff; marked by cross cut in triangular top of stone about 10 inches (25 cm) long and about 4 inches (10 cm.) wide, set flush with ground True bearings. east edge of east chimney on Cerro de Pasco Railway depot and hotel, 205° 19′.8; south edge of water tank, 242° 29′.9

Pacasmayo, Libertad, 1912—On high hill north of railway station, 15 or 20 feet (5 or 6 meters) from edge of hill, 84 5 feet (25 76 meters) southeast of southeast corner of Catholic cemetery, in line with northeast fence of cemetery, and in range between southeast corner and round stone 8 inches (20 cm) in diameter and 6 inches (15 cm.) thick sunk flush with ground and distant 3.9 feet (1 19 meters). True bearings: flagpole on railway station, 21° 57′.4; cross on church, 39° 11′ 4, mole light, 80° 41′.6, cross over gate of Chinese cemetery, 216° 30′.4.

Paita, Piura, 1912.—On high bluffs east of town, 486 feet (148.1 meters) southwest of northwest corner of new cemetery and 2.7 feet (0.82 meter) north of point in line with northwest wall of cemetery; marked by cross chiseled in a boulder 7 inches (18 cm) in diameter projecting about 3 inches (8 cm.) out of ground True bearings: base of cross on plain, 10° 06′.3; flagpole on customs building, 105° 17′.7; center of cross over cemetery gate, 268° 59′ 8

Pampa de Arrieros, Arequipa, 1912.—In pampa about 225 yards (206 meters) northwest of railroad water tanks and 185 paces west of railroad, measured from a point on railroad 24 paces north of stone-lined ditch under tracks; marked by cross in top of stone 6.5 by 10.5 by 12 inches (16.5 by 26.6 by 30 cm.), projecting slightly above ground and set with 10 5-inch (26.6 cm) edge in magnetic meridian. True bearing· south edge of south railroad water tank, 321° 41′ 3

SOUTH AMERICA.

PERU—*continued.*

Pisco, Ica, 1912.—In inclosed plot of ground east of smelter and about three-eighths mile (0.6 kilometer) north of mole, in range with north side of upper portion of smelter, 133.5 feet (40.69 meters) and 98.5 feet (30.02 meters) respectively from north and east fences of inclosed plot; marked by brass tack in top of wooden peg driven flush with ground and covered with small rocks. True bearings: flagpole on clock tower, 23° 42′.0; pole on central cupola of hotel, 29° 30′.7; knob on harbor light, 68° 56′.1; most southerly of three distant towers, 288° 57′.2.

Piura, Piura, 1912.—Midway between the two banks of river, about one-fourth mile (0.4 kilometer) north of bridge and opposite largest of a group of three houses on west bank; marked by brass tack in peg driven flush with ground. True bearings: right-hand corner of nearest building on west bank, 92° 05′.2; light over east pier of bridge, 359° 00′.5.

Platanos, Huanuco, 1912.—In clearing on high western bank of Pachitea River, 15 feet (4.6 meters) from edge of bank, 100 feet (30.5 meters) northeast of grass shed, 125 yards (114 meters) east of grass shed on hill, and south of small stream which flows through clearing and into Pachitea River; marked by copper nail in top of stake projecting one foot (30 cm.) out of ground.

Puerto Bermudez, Junin, 1912.—On top of high bank on west side of Pichis River, about one-third mile (0.5 kilometer) from wireless station, 50 yards (45.7 meters) northeast of northeast corner of inn, and nearly in front of house and hotel on plantation of Gumercindo Rivero; marked by copper nail driven in top of wooden stake set flush with ground. True bearing: east edge of second step from top of east wireless tower, 347° 63′.0.

Puerto Victoria, Junin, 1912.—In small clearing on east bank of Pichis River where it joins the Palcazu to form the Pachitea, 60 feet (18.3 meters) west of northwest corner of shed.

Puno, Puno, 1912.—In field on northwest edge of town and north of larger of two large hills or rock mounds, about 150 yards (137 meters) west of arch erected to the heroes of the independence, 83 feet (25.3 meters) and 59 feet (18.0 meters) respectively from large stones at north and south ends of stone wall, 11.2 feet (3.41 meters) west of stone wall measured from large stone with cross cut in its face; marked by brass tack in top of tent peg driven flush with ground. True bearings: white tip of south monument, 2 miles (3.2 kilometers), 257° 54′.1; east edge of wall of town cemetery, 1.5 miles (2.4 kilometers), 326° 10′.4.

San Lorenzo Island, Lima, 1912.—C. I. W. main station of 1908 was reoccupied. About 5.5 feet (1.7 meters) above and about 50 feet (15 meters) distant from ordinary high-water mark on beach, and approximately United States Coast and Geodetic Survey station of 1907; 79 feet (24.1 meters) and 67.4 feet (20.54 meters) from northeast and southeast corners of powder magazine (marked "deposito de explosives") which are in true bearing north 68°.7 west and south 34°.1 west respectively, and 57.5 feet (17.53 meters) from door of magazine directly beneath flagstaff; marked by a small round stake driven flush with ground. True bearing: square tower with clock in Callao 250° 29′.8.

San Nicolas, Junin, 1912.—In clearing in jungle, beside trail from Tarma to Puerto Yessup, and 73.6 feet (22.43 meters) east of southeast corner of inn; marked by copper tack in top of wooden peg driven flush with ground.

SOUTH AMERICA.

PERU—*continued.*

Santa Lucia, Puno, 1912.—In pampa west of railroad station, about 180 yards (165 meters) from railroad tracks and in line with west end of railroad engine shed, 28 paces west of gully known as Rio de Santa Lucia in rainy season, and in range with kilometer post 238, distant one-third mile (0.5 kilometer), and white boundary monument distant two-thirds mile (1 kilometer); marked by cross in rectangular top of reddish stone 3 by 5 by 10 inches (8 by 13 by 25 cm.). True bearings: kilometer post 238, 1° 22′.7; white boundary monument on mountainside, 197° 29′.2; north edge of north water tank, 312° 41′.5.

Santa Rosa, Puno, 1912.—In line with east wall of railroad hotel, 620 feet (189.0 meters) south-southwest of southeast corner of hotel yard, 29.5 feet (9.0 meters) north of sod wall, and 89.5 feet (27.3 meters) east of junction of two sod walls; marked by brass tack in top of tent peg driven flush with ground. True bearings: cross on top of mountain, 118° 06′.3; west edge of west tower of church in Santa Rosa, 185° 41′.2.

Sicuani, Cuzco, 1912.—East of town, in corner of alfalfa field on east side of road, opposite cemetery which lies between alfalfa field and railroad tracks, 42.5 feet (13.0 meters) from mud wall on west and 30 feet (9.1 meters) from mud wall on north; marked by brass tack in top of tent peg driven flush with ground. True bearings: east edge of white house with red tile roof at Hacienda Puerto Arturo, 17° 14′.4; west edge of chapel in field northwest of cemetery, 250 yards (229 meters), 86° 25′.2.

Tarma, Junin, 1912.—South-southeast of town, on slightly rising ground, about one-fourth mile (0.4 kilometer) south-southeast from cathedral and 13 feet 10 inches (4.21 meters) northwest of base of large painted wooden cross; marked by brass tack in wooden peg set flush with ground. True bearing: cross on tower of cathedral, 164° 23′.5.

Tirapata, Puno, 1912.—In pampa east of town, about 190 paces north of railroad, 100 paces east of gully, 181.5 feet (55.32 meters) north-northeast from junction of two mud walls, and in line with mud wall running at right angles to railroad and parallel to Calle de Tambopata about 140 paces to westward. True bearings: south edge of water tank in yard of Inca Mining Company, 90° 36′.0; kilometer post No. 67, 319° 41′.8.

Tres Unidos, Loreto, 1911.—On left bank of Maranon River, opposite mouth of Huallaga River, on west edge of path leading from river to main building of settlement, 5 meters from line of high water, 31.2 meters southwest of southwest supporting pillar of main building, and 8.1 meters south of flagpole; two trees east of path are 23.5 meters northeast and 7.9 meters east, respectively, and a line passing through the two trees and continued to river passes 3.1 meters southeast of station.

Trujillo, Libertad, 1912.—On elevation on north side of mound 100 feet (30.5 meters) in diameter and about three-eighths mile (0.6 kilometer) westward of main plaza, 50 feet (15.2 meters) south of southwest corner of brick-walled excavation, about 50 yards (46 meters) south of irrigation ditch, and about 100 yards (91 meters) east of two cement water-gate posts; marked by cross in top of tent peg sunk below surface of ground and covered by stone 6 by 12 by 4 inches (15 by 30 by 10 cm.) projecting slightly above ground. True bearings: spire on distant large building, 5° 51′.0; highest part of tower to westward, 131° 01′.2.

SOUTH AMERICA.

PERU—*concluded.*

Urcos, Cuzco, 1912.—North of railroad station and hotel, in pasture on southwest bank of Vilcanota River, 23 25 feet (7 09 meters) from outer edge of stone wall along river, and 21 feet (6 4 meters) southeast of old Spanish bridge pier; marked by brass nail in tent peg driven flush with ground.

Yzcuchaca, Huancavelica, 1912.—About one-half mile (0 8 kilometer) west of town, 63.7 feet (19.42 meters) west of west wall of cemetery, 121 5 feet (37.03 meters) and 87 feet (26 5 meters) respectively from northwest and southwest corners of cemetery, 16 feet (4.9 meters) east of gully; marked by brass tack in top of peg driven flush with ground. True bearing: tip of black rock on mountainside across Mantaro River, about 175 yards (160 meters), 164° 12′.0

URUGUAY.

Cerro Colorado, Florida, 1913.—On ranch San Juan Bautista, about 1 mile (1.6 kilometers) from railway station, on ridge running southeast from manager's house, 225 paces from southwest corner of manager's house, 131 paces south-southwest from sheepfold, in range with northeast corner of ranch residence and southwest corner of manager's house, and also in range with east side of sheepfold; marked by ash post projecting 1 inch (3 cm.) above ground. True bearings: right edge of white house near railway station, 39° 16′.7; southwest corner of manager's house, 156° 59′.8; right edge of sheepfold, 209° 04′.9.

Colon, Montevideo, 1913.—In grounds of Collegio Pio, about 130 feet (40 meters) south of Schwerer's 1895 and Brazilian Magnetic Commission 1904 station, 166.5 feet (50.75 meters) south-southeast from center of doorway in astronomical observatory building, 60 yards (55 meters) northwest of fence inclosing college grounds, and 130 feet (39 6 meters) southeast at right angles from point on roadway 108 feet (32.9 meters) southwest of doorway in front of astronomical observatory building True bearings: right edge of smokestack on pumphouse, 56° 01′.3; center of doorway in observatory building, 174° 29′.6; spire on college chapel, 221° 29′.4.

Durazno, Durazno, 1913 —On river flat belonging to municipality, about 600 yards (549 meters) southeast of southwest end of railway bridge, 115 feet (35 1 meters) west-northwest from edge of lake, 395 feet (120.4 meters) east-southeast from fence, and 57 feet (17 4 meters) southeast of small clump of bushes, marked by copper tack in top of tent peg projecting 1 inch (3 cm) above ground. True bearings: right edge of stone coping at southwest end of railway bridge, 134° 49′.6; right edge of smokestack, 176° 38′.7.

Melo, Cerro Largo, 1913.—In cemetery grounds, on hill southwest of town, 75 feet (22 9 meters) southeast from front fence, 58 feet (17.7 meters) west-southwest from easterly side fence, and 216 feet (65.8 meters) north-northwest from north corner of stone wall inclosing burial ground, marked by brass nail in top of tent peg. True bearings: prominent steeple in town, 154° 43′ 0; northeast corner of burial ground, 321° 35′.8.

Mercedes, Soriano, 1913 —In grounds of municipal stables, 319 feet (97.2 meters) southwest of southwest corner of stables, 177 feet (54 0 meters) east of fence, and 83 feet (25.3 meters) and 40 feet (12 2 meters) respectively west and west-northwest from two small trees; marked by tent peg projecting 1 inch (3 cm.) above ground. True bearings· center of windmill on ranch, 42° 02′ 1; southwest corner of municipal stables, 219° 05′.4.

SOUTH AMERICA.

URUGUAY—*concluded.*

Montevideo, Montevideo, 1913.—Near the United States Coast and Geodetic Survey station of 1907 in the Playa Capurro; at head of bay, about 260 feet (79 meters) from beach, 165 yards (151 meters) east of bath houses, 190 yards (174 meters) west-northwest of dwellings, and 300 yards (274 meters) southeast of fence surrounding an amusement park; marked by copper nail in top of tent peg driven flush with ground True bearings El Cerro Lighthouse, 70° 00′.1; right spire of church near by, 297° 42′ 3; spire of San Francisco Church, 355° 50′.7.

Punta del Este, Maldanado, 1913.—On east beach of Lighthouse Point, in open space called Playa de los Ingleses, about 500 yards (457 meters) west-southwest from British Hotel, 20 yards (18 meters) northwest from high-water mark, 156 feet (47.5 meters) and 175 feet (53.3 meters) respectively southeast and southwest from fences; marked by copper tack in top of tent peg. True bearings. lighthouse on point, 60° 03′ 2; lighthouse on an island, 317° 28′ 1.

Rivera, Rivera, 1913 —In exposition grounds, on ridge that runs in northerly direction from group of buildings, in line with west front of easternmost building, used as shelter for animals, 490 feet (149 4 meters) from northwest corner of building, and 132 feet (40.2 meters) from eastern boundary fence of grounds; marked by copper tack in top of tent peg projecting 1 inch (3 cm.) above ground. True bearings. right edge of exposition building, 35° 06′.9; left edge of barracks, 154° 25′.4; top of right wireless tower, 203° 51′.0.

San Eugenio, Artigas, 1913.—On municipal land sometimes used as parade ground, north of city and south of river, in line with northwest side of Santa Rosa Street, 620 feet (189 meters) northeast from west corner of Santa Rosa Street, 383 feet (116 7 meters) northwest from line of northwest side of Cuaray Street extended, and 35 feet (10.7 meters) south of small depression; marked by copper tack in top of tent peg driven flush with ground. True bearings: top of small cupola on barracks, 20° 26′.9; right edge of smokestack, 120° 27′ 6; spire of cathedral in San Juan Bautista, 233° 59′.4.

Tacuarembo, Tacuarembo, 1913 —In park Twenty-Fifth of August, 191 feet (58 2 meters) south of front fence, 238 feet (72.5 meters) east of center of carriage road, and north of lagoon; marked by brass nail in top of tent peg projecting 1 inch (3 cm.) above ground.

Treinta y Tres, Treinta y Tres, 1913 —About 500 yards (457 meters) west of railroad track, on a piece of ground belonging to town and sometimes used as horse and cattle market, about 240 yards (220 meters) southwest of cattle sheds, 171 feet (52 1 meters) northwest of fence, and 186 feet (56 7 meters) southeast of municipal boundary mark built of brick and covered with concrete; marked by tent peg driven flush with ground. True bearings. left edge of municipal boundary mark, 112° 32′ 7, right spire of cathedral in town, 218° 11′.4; right edge of water tank at railway station, 308° 29′.2.

VENEZUELA.

Aroa, Lara, 1912 —About one-fourth mile (0.4 kilometer) northwest of machine shops, 22 feet (6.7 meters) from west edge of stream, and 39 feet (11.9 meters) north of sharp bend in stream; marked by cross in top of stone 5 by 9 inches (13 by 23 cm.) on top, projecting 2 inches (5 cm) above ground. True bearings: iron chimney on machine shops, 305° 14′.5; left-hand corner of nearer of two large square chimneys, 343° 17′.6.

SOUTH AMERICA.

VENEZUELA—*continued.*

Baltazar, Amazonas, 1913.—On east bank of Atabapo River, near center of plaza, 7.5 feet (2.3 meters) south of point in line with north end of church, and about 90.5 feet (27.6 meters) east of north corner of church.

Barcelona, Anzoategui, 1913.—In northwestern part of town, about 6 blocks north and 2 blocks west of northwest corner of main plaza, about 103 feet (31.4 meters) north of last house on street, and 11 feet (3.4 meters) west of line tangent to fronts of houses on west side of street; marked by tent peg driven flush with ground.

Barquisimeto, Lara, 1912.—About one-half mile (0.8 kilometer) north-northeast of church, on first elevated ground beyond edge of town, a short distance east of small stone quarry, about 75 yards (69 meters) east of road which goes to west of quarry, 15 feet (4.6 meters) west from center of large stone, 23.5 feet (7.16 meters) southwest of piece of petrified tree trunk, and about 32.5 feet (9.9 meters) south-southeast of large stone; marked by wooden peg projecting slightly above ground. True bearings: head of statue on left of twin towers, 7° 20′.0; knob on pole on large church dome, 27° 00′.4; cross on monument, 309° 08′.0.

Barrancas, Bolivar, 1913.—Northeast of town, about 100 yards (91 meters) from customhouse, 39 feet (11.9 meters) from Orinoco River, 23 feet (7 meters) southwest of dense tree hedge, and 83.6 feet (25.48 meters) east of lone tree. True bearing: cross on church facing plaza, 123° 51′.7.

Caicara, Bolivar, 1913.—On east bank of Orinoco River, about 100 yards (91 meters) south of main landing, about midway between first and second trees from landing, 97.3 feet (29.66 meters) west of barbed-wire fence, 198 feet (60.4 meters) southwest of northwest corner of fence, and about 20 feet (6 meters) east of river bank.

Caracas,[1] *Federal District,* 1912, 1913.—The C. I. W. station of 1905 was reoccupied. On same hill as observatory, 63.2 feet (19.26 meters) northeast of northeast corner of foundation on east side of observatory, 33.6 feet (10.24 meters) northeast of center of round instrument pier, 43 feet (13.1 meters) east of center of large boulder, and 49 feet (14.9 meters) southeast of center of large rectangular pier; marked by hole in top of marble post 3.5 by 6 by 27 inches (9 by 15 by 69 cm.) projecting about 2 inches (5 cm.) above ground and lettered on top C. I. 1905. True bearings: gateway near west side of large inclosure, 175° 02′.6; east spire of Pantheon Nacional, 240° 14′.4; clock tower facing Plaza Bolivar, 259° 48′.2.

Carache, Trujillo, 1912.—About three blocks south of plaza, 12.5 feet (3.81 meters) south of stream, and in line with southwest side of street, which is one block southwest of southwest side of plaza. True bearings: cross on church facing plaza, 182° 11′.5; cross on hill, 202° 42′.1.

Carupano, Sucre, 1913.—West of central part of town, 190 feet (57.9 meters) southwest of southeast corner of cemetery, and 128 feet (39.0 meters) south of south wall of cemetery, measured from junction with stone partition wall; marked by tent peg driven flush with ground. True bearings: center of cross over cemetery gateway, 175° 38′.0, knob on pole on lighthouse tower, 182° 50′.4.

[1] The description of the 1905 station at Caracas, published in Volume I, is in error as regards directions and should be replaced by the present description.

SOUTH AMERICA.

VENEZUELA—*continued.*

Casimirito, Bolivar, 1913.—On east bank of river, opposite north end of Isla Cabullarito, above mouth of Rio Cabullare, about 100 yards (91 meters) north of only house in this neighborhood, and 25 feet (7.6 meters) east of highest ridge of highest rock in lower group near bank.

Ciudad Bolivar, Bolivar, 1913.—On opposite side of Orinoco River from city, near second group of large boulders below Soledad, 40 feet (12.2 meters) north of deep cross cut in top of large boulder of lighter color than others of group, this cross being in range between station and cross on church; marked by tent peg driven flush with ground. True bearing: cross on church tower, 355° 29′.9.

Comunidad, Amazonas, 1913.—On east bank of Guainia River, about 15 feet (5 meters) south of large stone used for landing place, about 80 feet (24 meters) west of west corner of large shed, and about 100 feet (30 meters) northwest of northwest corner of another large shed.

Cumana, Sucre, 1913.—In north edge of town, and distant from north corner of plaza 1 block northwest and 3 blocks northeast, and thence due north along road about 2 blocks to point where road turns about 30° to left, thence about 100 feet (30 meters) northward to point in line with road, 371 feet (113.1 meters) southwest of fern tree, and 44 feet (13.4 meters) south-southwest from nearest tree in row of trees and bushes; marked by tent peg driven flush with ground. True bearings: center of smokestack of factory power plant, 13° 13′.9, flagpole on fort, 332° 17′.0; center of ornament on unfinished theater, 350° 55′.2.

El Tigre, Bolivar, 1913.—On north bank of river, near former Isle de Tigre (recently disappeared), 10 feet (3.0 meters) from bank, near scattering settlement.

La Ceiba, Trujillo, 1912.—About 200 yards (183 meters) south of railway station, 100 feet (30.5 meters) south of last house, 8 feet (2.4 meters) east of shore of lake, 91.5 feet (27.89 meters) from northeast corner of sheltered platform in lake used for loading boats, and 26 feet (7.9 meters) south of crooked palm tree; marked by brass tack in tent peg driven flush with ground. True bearing: tall pole on end of mill, 151° 06′.5.

Las Bonitas, Bolivar, 1913.—Near east edge of large open space between river and town, in line with east side of main street, southeast of stockyards, and about 80 yards (73 meters) from river, and same distance from corner store on west side of main street. True bearing: upstream edge of largest rock of group called "Las Bonitas" in middle of river, 148° 53′.7.

La Urbana, Bolivar, 1913.—On south bank of Orinoco River, west of group of houses on next street south of river, in line with street, 87 feet (26.5 meters) west of large tree in street line.

Maipures, Amazonas, 1913.—Southwest of main part of town, at first bend of road between Maipures and Tuparo, north of barracks, in an abandoned road, 62 feet (18.9 meters) north of edge of used road, and 102 feet (31.1 meters) west-northwest from large, low, round stone.

Mapire, Bolivar, 1913.—About 300 yards (274 meters) north of lower landing place, beyond the group of houses, about midway between line of street from landing and street next west, and about 75 yards

SOUTH AMERICA.

VENEZUELA—*continued.*

Mapire, Bolivar, 1913—continued
(68 meters) northward from last house on each street. True bearing: leftmost monument with cross in cemetery, 62° 18'.4.

Maracaibo, Zulia, 1912.—In the plain northwest of town, about 3 kilometers from wharf end of tram line, about 200 yards (183 meters) at right angles northeast from tram line at the only cut between Maracaibo and Bella Vista, 25 feet (7 6 meters) east of sandy road, and 89.7 feet (27 34 meters) southwest of low, bushy thorn tree; marked by brass tack in top of tent peg projecting slightly above ground True bearings: windmill, 21° 43'.4; pumping rod on windmill, 104° 18'.8; center of windmill, 188° 23' 4.

Marida, Amazonas, 1913.—On west bank of river, about three-fourths mile (1.2 kilometers) downstream from Cerro Mono, about 45 yards (41 meters) downstream from larger of two houses of the garden "Marida" of Señor Le Vanti, about 10 feet (3 meters) from edge of bank, and 28 feet (8 5 meters) from small inconspicuous cross.

Moitaco, Bolivar, 1913.—On point of land immediately north of town, 151 feet (46 meters) north of large mango tree in front of mayor's house, and 82 feet (25 0 meters) west of long, dense hedge of trees. True bearing: center of tower on church, 339° 03'.1.

Pedernales, Amacuro, 1913.—Near more southwesterly of two villages of same name, on shore, northeast of customhouse, 34.1 feet (10.39 meters) north-northeast of north corner of last house, 23 7 feet (7.22 meters) northwest of fence, and short distance southwest of small knob surmounted by cross

Puerto Cabello, Carabobo, 1912.—South of town, near south edge of large, flat, sandy tract subject to overflow, in line with front wall of cemetery, about 200 yards (183 meters) east of northeast corner of cemetery, and 75 yards (69 meters) west of fairly well-defined edge of area subject to overflow. True bearings: flagpole of fort on hill, 81° 54' 4; rod on top of large round chimney, 133° 27'.8; base of pole on far end of meat cannery, 191° 43' 6.

Sabana de Mendoza, Trujillo, 1912—About 300 yards (274 meters) northeast of railway station, on open alluvial tract of ground, in line with street running northeast from railway station, 70 yards (64 meters) southwest and 35 yards (32 meters) east respectively of two large trees

San Carlos, Amazonas, 1913—Southeast of plaza and south of church, 170 feet (51.8 meters) northwest of northwest corner of long, substantial building, 129 5 feet (39 47 meters) southwest of southwest corner of long building, and 109 feet (33.2 meters) southeast of southeast corner of long shed at southeast corner of plaza; marked by tent peg driven flush with ground.

San Felix, Bolivar, 1913.—In northeast part of town, between river and road, about 200 yards (183 meters) northeast of Piar monument, 109 feet (33 2 meters) southwest of barbed-wire fence, and 80 feet (24.4 meters) northwest of road. True bearings. nose on Piar monument, 35° 43'.0, cross on church, 297° 29'.7.

San Fernando de Atabapo, Amazonas, 1913—In cleared space just east of houses, in line of street one block south of south side of plaza, 80 yards (73 meters) southeast of church, 4 feet (1 2 meters) south of general line of buildings on north side of street, 63 feet (19.2 meters) northeast of northeast corner of barbed-wire fence on south side of street.

SOUTH AMERICA.

VENEZUELA—*concluded.*

Santa Maria, Apure, 1913.—On west bank of Orinoco River, about 10 feet (3 meters) from top of river bank, and 26.6 feet (8.10 meters) east of northeast corner of larger of two main houses of settlement.

Tocuyo, Lara, 1912.—South of town and north of small stream, about in line with third street east of west side of town plaza, 51 5 feet (15 70 meters) south of a brush fence, and 42.5 feet (12 95 meters) southwest of corner of wire fence; marked by cross cut in top of tent peg driven flush with ground

Trujillo, Trujillo, 1912.—Near junction of one large and two small valleys, north of town, one-fourth mile (0.4 kilometer) from church facing main plaza, 95 feet (29 0 meters) south of prominent tree at foot of hill, and 43 feet (13.1 meters) northeast of bush locust tree; marked by brass tack in tent peg driven flush with bottom of excavation about 2 feet (61 cm.) deep. True bearings dome of more distant church, 77° 04' 1; dome of church facing main plaza, 79° 22' 0; cupola of farmhouse up valley, 296° 45'.1.

Tucupita, Amacuro, 1913—On northeast shore of river, 25 feet (7 6 meters) from edge of river bank, 51 feet (15 5 meters) from row of houses, 35 feet (10 7 meters) and 74 6 feet (22.74 meters) respectively south and northwest from mango trees, and about midway between church and northwest end of row of houses

Turmero, Aragua, 1912—West of town, on small knoll at foot of large hill, 20.6 feet (6 28 meters) west of large cross supported by pile of stones, and short distance southwest of small house on west side of small stream which is 125 yards (114 meters) west of larger stream bordering town on west; marked by tent peg driven flush with ground.

Yavita, Amazonas, 1913—In west corner of plaza, 71 5 feet (21.79 meters) southeast of front of ruined houses, 118 feet (36 0 meters) northwest of large wooden cross, and 157 feet (47.9 meters) southwest from substantial building on northeast side of plaza.

Zamuro, Amazonas, 1913.—On east bank of Orinoco River and east of road to Atures, on low mound about 90 yards (82 meters) from landing place, in line with north end of storehouse, 96 feet (29 3 meters) east of northeast corner of store, and 50 feet (15 2 meters) west of center of more northwesterly of two large round rocks 5 feet (1 5 meters) high and 30 feet (9 1 meters) in diameter

ISLANDS, ATLANTIC OCEAN.

CANARY ISLANDS.

Arecife, Lanzarote Island, 1912.—On plain west of town, on north side of well-made road, opposite cemetery inclosed by stone wall, 316 paces northeast of entrance to cemetery, and 144 paces north of kilometer stone; marked by wooden peg covered over with earth. True bearings. cross over entrance to cemetery, 40° 29'.6; clock tower in Arecife, 272° 53'.7.

Las Palmas, Grand Canary, 1911, 1912—The station of 1911 is practically identical with that of 1912 The latter is on heights between Port La Luz and Las Palmas, about three-fourths mile (1.2 kilometers) west of convent and Hotel Metropole, on level plot of ground excavated out of hillside in angle between main road and branch road which goes off to south-southwest; 5 meters west of center of main road, 10.4 meters northwest of tree at fork of roads, 12 meters northeast of bench on west side of park, and 33 meters north of bench in south corner of park; marked by wooden peg

ISLANDS, ATLANTIC OCEAN.

CANARY ISLANDS—*continued*

Las Palmas, Grand Canary, 1911, 1912—continued. driven flush with ground. True bearings: center edge of chimney of Hotel Metropole, 270° 22′.8; cross on church in Las Palmas, 314° 33′ 8; lightning rod on tall smokestack in Las Palmas, 315° 23′.4.

Morro Jable Point, Fuerteventura Island, 1912 —In small valley about 70 paces north and north-northwest respectively from two groups of stone huts which stand at mouth of valley near shore.

Santa Cruz, Teneriffe, 1911.—About 150 yards (137 meters) east of northeast corner of Quisisana Hotel, on second terrace below driveway in front of hotel, 22 feet (6.7 meters) east of wall of next higher terrace, 14 feet (4.3 meters) west of wall of next lower terrace, and 19 feet (5 8 meters) southwest of palm tree; marked by wood stake. True bearings: east side of large stone nunnery, 20° 21′.1; flagpole on hotel, 99° 24′.3; west wireless tower, 344° 42′.9.

Santa Cruz, Teneriffe, 1912.—On coast, several kilometers southwest of Santa Cruz, in field belonging to Señor Nicolas Diaz Beautell; 100 meters southwest of house of Señor Beautell, 49 paces southwest of center of retaining wall, and 43 paces southeast of center of road; marked by wooden peg driven flush with ground. True bearings: ornament on northeast corner of large house, 1.2 kilometers, 118° 40′ 3; tower in Santa Cruz, 230° 32′.7; brick smokestack in Santa Cruz, 232° 16′.6.

FALKLAND ISLANDS.

Port Stanley, East Falkland Island, 1913.—Three stations, designated *A*, *B*, and *C*, were occupied. *A*, the "variation station" of British Admiralty, is on top of ridge at Navy Point in saddle between two clusters of outcropping rocks; marked by square stone projecting about 1 foot (30 cm.) above ground and having piece of marble with hole at center and word "variation" cut in, set in top. True bearings: flagstaff above town, 41° 56′ 2; *B*, about 1 5 miles (2 kilometers), 63° 09′.3; wireless mast, 302° 27′.0. *B* is on hillside across bay from *A*, southwest of Governor's residence, and south of quarters of naval surgeon, in slight depression north of clump of gorse bushes, 21.2 meters south of wire fence inclosing premises of naval surgeon. True bearings: *A*, 243° 10′.5; cathedral spire, 270° 48′.5. *C* is 50 5 meters true south 182° 51′.4 west of *B*, 45.0 meters north of east-west fence.

ST. HELENA.

Longwood, 1913.—Four stations designated *A*, *B*, *C*, and *D*, were occupied. Main station *A* is on triangular lawn west of house in which Napoleon died, 53.05 meters west-southwest from southwest corner of north post of yard gate, 34 1 meters northwest of west corner of masonry support for three water tanks, and 13.1 meters due north of point in line with flax hedge; marked by cross cut in top of spruce post driven flush with ground and covered with sod. True bearings: northeast corner of house, 82° 13′.7; flagpole at High Knoll Fort, 102° 31′.5; prominent rock on Signal Hill, 186° 32′.7; north gable of stone house on hill, 345° 54′.1. *B* is 26.4 meters west-southwest from *A* on azimuth line to northeast corner of house, 12 7 meters north of flax hedge, and 21.7 meters southeast of iron telephone pole; marked by cross cut in top of tent peg driven flush with ground. True bearings: northeast corner of house, 82° 13′ 7; flagpole at High Knoll Fort, 102° 40′.1; prominent rock on Signal Hill, 186° 59′.0; north gable of stone house on hill, 345° 05′.2. *C* is 27.25 meters west-southwest from *B* on azimuth line to northeast corner of house, 27.9 meters south-

ISLANDS, ATLANTIC OCEAN.

ST. HELENA—*concluded.*

Longwood, 1913—continued southwest from iron telephone pole, and 11 6 meters north of flax hedge True bearings· northeast corner of house, 82° 13′.7; flagpole at High Knoll Fort, 102° 49′ 4; prominent rock on Signal Hill, 187° 26′ 3; north gable of stone house on hill, 344° 14′.3. *D* is about 75 yards north of old magnetic observatory in open field, 11 paces north of fence along north side of yard in front of Mr. Fred M Deason's house. True bearing: west edge of stone house, one-half mile (0.8 kilometer), 167° 33′.3.

WEST INDIES.

Port of Spain, Trinidad, 1913.—Station of 1905 and 1908 was reoccupied. In grounds of Agricultural Experiment Station, just west of extreme northwest corner of Queen's Park Savannah, and near turning-point of St Clair Electric Car Line, 65 2 feet (19.87 meters) from west fence and 58 feet (17.7 meters) from south edge of roadway passing superintendent's office; marked by hole in top of limestone post 6 by 6 by 30 inches (15 by 15 by 76 cm.) projecting 4 inches (10 cm.) above ground and lettered on top C I.1905. True bearings: flagpole on French bishop's house, 320° 56′ 1; flagpole on Mr Stollmeyer's house, 306° 33′ 9.

Willemstad, Curaçao Island, 1913.—South of town, on knoll on coral bar connected with west half of town, about 150 yards (137 meters) from electric lighting plant, 60 feet (18 3 meters) north of road, and 10 feet (3 0 meters) north of line of brush; marked by brass tack in tent peg driven flush with ground. True bearings: prominent flagpole, 227° 09′ 0, flagpole on ice plant, 245° 50′.9; south flagpole at baths, 307° 05′.4.

ISLANDS, INDIAN OCEAN

CEYLON.

Colombo, 1911 —Three stations, designated *A*, *B*, and *C*, were occupied in western part of grounds of Colombo Observatory. *A* is 108 feet (32 9 meters) from southwest fence, 164 feet (50.0 meters) southwest of southwest corner of office building, 80.62 feet (24.57 meters) west of thermometer shelter, and 69 8 feet (21.28 meters) northeast of large tree, marked by cement block 3 feet (0 9 meter) long and 5 inches (12 7 cm.) square at top, lettered on top "C.I.W 1911" True bearings: northwest corner of lunatic asylum, 55° 40′.6; small white upright over east gable of "Grasmere," the Surveyor-General's bungalow, 177° 25′.8, southeast corner of office, 235° 30′.3. *B* is 217.67 feet (66 35 meters) north of *A*, on azimuth line to "Grasmere." *C* is 84 62 feet (25.79 meters) north of *A*, on azimuth line to "Grasmere"

Colombo, Cinnamon Gardens, 1911.—In vacant lot owned by Mr. S. M. Fernando, on north side of Bogatelle Road, Cinnamon Gardens, opposite La Corniche Bungalow, 102 4 feet (31 21 meters) north of wire fence along road, 124 feet (37.8 meters) east of stone wall on west side of lot, and 19 2 feet (5 85 meters) northwest and northeast respectively from two palm trees.

JAVA.

Weltevreden (Batavia), 1911.—Two stations, designated *A* and *B*, were occupied in grounds of Royal Magnetic and Meteorological Observatory *A* is 13 35 meters southwest of southwest corner of foundation of absolute house, 22 6 meters northwest of east end of brick wall at rear of grounds True bearing: azimuth mark of observatory, line on concrete pillar near west side of main entrance, 178° 14′ 1. *B* is on azimuth line from

ISLANDS, INDIAN OCEAN.

JAVA—*concluded.*

Weltevreden (*Batavia*), 1911—continued.
A to mark, 14 87 meters north of *A*, and 11 30 meters west of southwest corner of foundation of absolute house. For intercomparisons with observatory standards, observations were made on piers in absolute house of observatory, declination being observed on declination pier, horizontal intensity on piers *A* and *C*, and inclination with earth inductor on earth-inductor pier.

MAURITIUS.

Pamplemousses, 1911.—Four stations, designated *A*, *B*, *C*, and *D*, were occupied in grounds of Royal Alfred Observatory. *A* is central pier of absolute house. True bearing: observatory azimuth mark, 0° 01′.3. *B* is 6 41 meters south of *A*, in line to azimuth mark. *C* is 42.38 meters south of *B*, in line from *A* to azimuth mark. *D* is dip pier of observatory, 1.53 meters west of *A*.

ISLANDS, PACIFIC OCEAN.

FIJI ISLANDS.

Suva Vou, Viti Levu Island, 1912.—Two stations, designated *A* and *B*, were occupied. *A* is reoccupation of C.I W station of 1906, and H M.S. *Waterwitch* station of 1896; on north side of bay, about 2 miles (3 kilometers) from Suva, on point of land near missionary station of Seventh-Day Adventists; marked by concrete post projecting 18 inches (45.7 cm.) out of ground, and having an arrow and year 1896 cut on east face. True bearings: outer lighthouse, 31° 00′ 0; lower lighthouse, 129° 54′.5; flagstaff on governor's house, 342° 36′.1; boathouse, 348° 35′.9. *B* is on same bluff, 2 meters from east edge of cliff, 32 4 meters north-northeast of *A*. True bearings: outer lighthouse, 31° 11′.0; flagstaff on governor's house, 343° 00′.4; boathouse, 349° 01′.3.

MACQUARIE ISLAND.

Caroline Cove, 1911.—At head of long, narrow indentation in southwest corner of Macquarie Island, entrance to which is well covered with rocks; on somewhat peaty bench above sand and shingle beach, at foot of steep hills about 100 feet (30 5 meters) from sea-front, about 3 meters above sea-level, and about 25 meters east of two iron boiling-down pots used by sealers; marked by wooden peg. True bearing: most seaward pointed rock on right of inlet mouth, 169° 35′.6.

North End Settlement, 1911.—A main station, designated *A*, and three secondary stations, designated *B*, *C*, and *D*, were occupied. *A* is at north end of Macquarie Island, at base of sandy and boggy spit which connects high promontory with mainland, 199 feet (60 7 meters) west of shore line, 160.5 feet (48.92 meters) east of northeast corner of newer of two huts standing under shelter of rocky ridge which extends north-eastward into spit, 179 feet (54.6 meters) south-southwest of southwest corner of galvanized-iron shed used as a boiling-down house; marked by wooden peg 2 by 3 inches (5 by 8 cm.) set with top just beneath surface. True bearings· nearest corner of new wooden hut, 82° 10′.4; southwest corner of boiling-down house, 191° 23′.0; nearest mast of wireless station, 206° 19′.9; pointed rock off coast, 236° 02′ 3; Sugarloaf Rock at Nuggets, 4 5 kilometers, 354° 56′.9 *B* is about 120 yards (110 meters) south of *A* in direction of Sugarloaf Rock. *C* is 220 yards (201 meters) north of *A*, in range with *A* and Sugarloaf Rock. *D* is on rock 200 yards (183 meters) from shore, about 400 yards (366 meters) from *C*, from which it bears 171° 52′.8 true.

ISLANDS, PACIFIC OCEAN.

PHILIPPINE ISLANDS.

Antipolo, 1912.—Three stations, designated *A*, *B*, and *C*, were occupied at Antipolo Observatory. *A* is pier in absolute house. True bearing: mark on large mango tree, 359° 58′.8. *B* is on broad walk in front of variation observatory, 25 8 meters from middle of lower front step of observatory. True bearings: absolute observatory mark, 5° 47′.8; windmill top, 135° 18′.2; southeast corner of variation observatory, 188° 08′.2; staff of vane on wind-tower, 277° 07′.2. *C* is on broad walk in front of variation building, in line with *B* and mark on small bungalow at rear of hotel, 26.7 meters south of *B*, 59.9 meters from point 4 feet above ground on mango tree on which is placed declination mark for absolute house. True bearings: center of windmill top, 143° 07′ 9; southeast corner of variation observatory, 183° 16′.8; staff of vane on wind-tower, 263° 06′ 7.

SAMOAN ISLANDS.

Apia, Upolu Island, 1911.—On pier in absolute house of Apia Magnetic Observatory.

Pago Pago, Tutuila Island, 1911.—Near south boundary of parade ground between barracks and a native's house, 162.6 feet (49 56 meters) from bottom of northwest edge of west wing of barracks and 79 feet (24.1 meters) from cut in bottom of lone orange tree to the east; marked by tent peg True bearings. bottom northeast edge of schoolhouse, 127° 39′.8; middle bottom flagstaff, 135° 26′.1; gable of roof of west side of schoolmaster's house, 239° 55′.2; bottom northwest edge west wing of barracks, 265° 50′.1.

Tau, Manua Island, 1911.—Station *A* was about 40 yards southwest of flagpole near cooperative store of village of Tau, and about 500 feet south of Queen Vaitupu's house. Marked by stake about 2 inches (5 cm.) thick and about 3 feet or a meter long sunk flush with sandy soil. Stake is 219.6 feet (66.94 meters) from southeast edge of small house to south-southwest, 35 feet (10 7 meters) from breadfruit tree to southeast, and 14.5 feet (4.42 meters) from cocoanut palm to southwest. *A* was the station for magnetic observations during total solar eclipse of April 28, 1911. True bearings: principal mark (*V*), the southwest edge of east window on south side of Queen Vaitupu's house, 186° 03′; secondary mark (*M*), used temporarily for magnetometer work, southeast edge (12 inches or 30 cm. from top) of small house 219.6 feet (66.94 meters) distant, approximately 21° 32′ A secondary station, *B*, used for azimuth and dip observations, was placed in line from *A* to mark *M* and was 80.1 feet (24 41 meters) distant from *A*.

SOCIETY ISLANDS.

Papeete, Tahiti Island, 1912.—In eastern corner of tract of government land immediately south of Botanical Garden, about 106 meters south-southeast of gardener's house, 47.3 meters northeast of northeast cornerstone of windmill pump, 8.8 meters southeast and 12.7 meters southwest respectively from two cocoanut trees, 15 2 meters north of tropical chestnut tree, and approximately 15 and 41 meters respectively from west and north fences of tract. True bearings: windmill vane, 29° 46′.1; corner of house of Chief Justice, 107° 14′.2; east edge of gardener's house, 158° 02′.8.

Small Coral Island (*Papeete Harbor*), *Tahiti Island*, 1912 —Two stations, designated *A* and *B*, were occupied on small coral island about one-half kilometer west of white obelisk on Soactoi reef south of entrance to Papeete Harbor, and not far from station of *Galilee* party in 1907, which, owing to changes in topo-

ISLANDS, PACIFIC OCEAN.

SOCIETY ISLANDS—*concluded.*

Small Coral Island (Papeete Harbor), Tahiti Island, 1912—continued.
graphy on account of storms and the building of small hospital and wharf, could not be recovered. *A* is on north extremity of island. True bearings: northwest corner of hospital, 4° 00'.9; channel gun, 240° 04'.0; cathedral spire, 267° 40'.4, north obelisk, 276° 13'.1, upper range-light, 295° 57'.7, south obelisk, 316° 51'.6; northeast corner of hospital, 49.6 meters, 345° 46'.9. *B* is on south extremity of island, about 88 meters south of *A*. True bearings: mountain peak on northeast end of Moorea Island, 100° 14'.2; northwest corner of hospital, 36.3 meters, 189° 56'.8; southwest corner of hospital, 227° 52'.0; upper range-light 292° 03'.2; south obelisk, 310° 26'.9.

ANTARCTIC REGIONS.

VICTORIA QUADRANT.

Australasian Antarctic Expedition Base 2 (Igloo), 1912.—In snow hut on barrier ice where soundings give a depth of 220 fathoms (402 meters), 14 miles (22.5 kilometers) from nearest land.

Australasian Antarctic Expedition Base 2 (Tent), 1913.—On line between igloo and mark which is in true bearing 65° 34'.1.

Commonwealth Bay, Adelie Land, 1912, 1913.—Observations were made at five stations, designated *A*, *B*, *C*, *D*, and *E*.

Station *A*.—During the 11 months of occupation by the Australasian Antarctic Expedition, observations were made regularly in the absolute hut situated about 300 yards (274 meters) northeast of winter hut quarters.

Station *B*.—In excavation in ice about one-half mile (0.8 kilometer) from first appearance of solid rock, about 600 meters from morainic termination of glacier at altitude of 345 feet (105 meters) above sea level, 3,849 feet (1,173 meters) from *A*. True bearings: west azimuth mark of *A*, 3,820 feet (1,164 meters), 147° 04'.2; *A*, 166° 56'.

Station *C*.—On rocky ridge west of boat harbor, about 800 feet (244 meters) northwest of hut quarters, about 2 chains (40 meters) north of spot where west azimuth mark of *A* was subsequently placed.

Station *D*.—Two chains (40 meters) east of absolute hut.

Station *E*.—By sledge meter 11 miles 750 yards (18.4 kilometers) practically due south of Commonwealth Bay, 1,990 feet (581.9 meters) above sea level, on slight rise beyond which plateau rises evenly for several miles. The sledge journey from absolute hut was over ice heavily crevassed, with no appearance of rock.

Eastern Sledge Journey, 1912.—The Australasian Antarctic Expedition in November 1912 sent out a party which made observations of declination and inclination along coast to eastward, at points which are generally described by the direction of the route from station to station, and by distance obtained by sledge meter running continuously from winter quarters to last point at which observations were made. These points are numbered in order of occupation and are further described by latitude and longitude, which are given for each case in the Table of Results

1. At 55¾ miles (89.7 kilometers) southeast of Commonwealth Bay, on ice-covered hill about 1,000 feet (305 meters) above surrounding country. Rock outcrop was not evident from this hill, but was visible on similar hill, later referred to as Mount Aurora, 5 to 8 miles (8 to 13 kilometers) south.

2. At 73¾ miles (118.7 kilometers) southeast from winter quarters.

3. At 107 miles (172.2 kilometers) southeast from winter quarters, on barrier about 7 miles (11 kilo-

ANTARCTIC REGIONS.

VICTORIA QUADRANT—*concluded.*

Eastern Sledge Journey, 1912—continued
meters) from tongue of ice pushed out by pressure of a glacier, and perhaps 20 miles (32 kilometers) from shore.

4. On sea ice at 112 miles (180.2 kilometers) by meter from winter quarters and nearly due east of station 3.

5. On sea ice at 152¼ miles (247.7 kilometers) from winter quarters, southeast of station 4, and 20 or 30 miles (32 or 48 kilometers) out from apparent coast line

6. On sea ice 200 miles (321.9 kilometers) from winter quarters, southeast of station 5

7. A station auxiliary to station 8 at 220 miles (354.1 kilometers).

8. On sea ice at 223 miles (358.9 kilometers) by sledge meter, and south-southeast from station 6.

9. On barrier at 270 miles (434.5 kilometers) by sledge meter from winter quarters, and south-southeast of station 7. This is farthest point reached by eastern party, and is about 17 miles (27.4 kilometers) north-northeast of large rock outcrop noted as Dreadnought Bluff

10. Southwest of station 9, 5 miles (8 kilometers) toward Dreadnought Bluff from 270-mile Camp.

11. Southwest of station 9, 13¼ miles 21.3 kilometers) toward Dreadnought Bluff from 270-mile Camp.

12. On return journey at rock outcrop called Penguin Point, about 16 miles (25.7 kilometers) south-southeast of 107-mile Camp (station 3). The sledge meter running continuously since leaving winter quarters read 417 miles (671.1 kilometers).

13. On glacial tongue on barrier, about 10 miles (16 kilometers) southeast of 55-mile Camp and about same distance east of Mount Aurora, at sledge-meter reading 464½ miles (747.1 kilometers).

Southern Sledge Journey, 1912.—In November 1912 the Australasian Antarctic Expedition sent out a party from the winter quarters at Commonwealth Bay, whose route lay toward the highlands of the interior. Stations, which were occupied at intervals, are described by the general direction of the course followed and the distance by sledge meter from the point of departure at winter quarters.

1. At 30 miles (48 kilometers) on course 10° east of south Height above sea level 3,415 feet (1,041 meters)

2. At 67½ miles (108.6 kilometers) on course 10° east of south, at an elevation of 2,221 feet (677 meters) above sea level An auxiliary station, *2A*, was occupied 80 meters east of declination station.

3. At 100¾ miles (162 kilometers) on course south 45° east from station 2, at an elevation of 2,753 feet (839 meters)

4 At 174.8 miles (281.3 kilometers) after traversing courses as follows: nearly due south to 120 miles, south 7° west to 132 miles, and south 45° east to station

5. At 200 miles (322 kilometers) following course from station 4 that varied from 10° to 20° east of south This point was reoccupied on return.

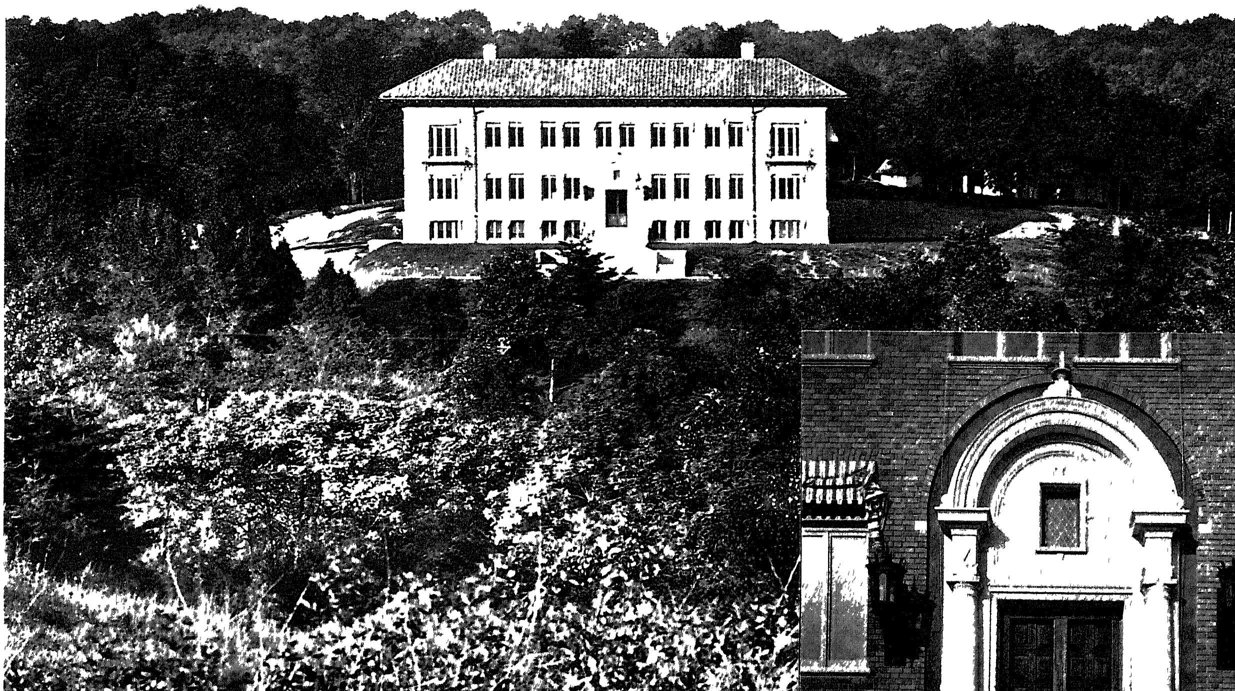
6. At 249 miles (400.7 kilometers) on course from station 5 bearing 45° east of south This point was reoccupied on return

7. At 301 miles (484 kilometers) after continuing southeasterly course pursued since leaving station 5. This station was most southerly reached and lies at an elevation of 5,900 feet (1,798 meters) above sea level

8. On return journey about 33 miles (53 kilometers) north of station 4 or about 142 miles (229 kilometers) from winter quarters, sledge meter reading 460 miles (740 kilometers), running continuously from starting-point at Commonwealth Bay.

REPORTS ON SPECIAL RESEARCHES

BY L. A. BAUER AND J. A. FLEMING



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Research Buildings of Department of Terrestrial Magnetism.

1. General view of main building (headquarters and laboratory) and of grounds.

2. Detail view of front entrance to main building 3. Standardizing magnetic observatory

RESEARCH BUILDINGS OF DEPARTMENT OF TERRESTRIAL MAGNETISM.

By L. A. Bauer and J. A. Fleming.

INTRODUCTORY REMARKS.

The Department of Terrestrial Magnetism, from its establishment on April 1, 1904, until the latter part of February 1914, was housed in rented quarters at Washington, D. C., for the greater time in the Ontario Apartment House, located in the northwest suburban section of the city. With the rapid development of the work of the Department and the requisite increase in the personnel, and because of the establishment, in January 1908, of a shop for the construction of new and improved instruments, additional quarters had to be rented from time to time until, in 1913, 16 rooms were required. During this period it was necessary to carry on the observational and experimental researches, such as the testing and intercomparisons of instruments, determination of instrumental constants, experimental investigations concerning causes of changes in constants, improvements in instruments and methods, etc., under more or less unfavorable conditions, in two non-magnetic huts on a small piece of ground overlooking the Zoological Park, about 300 feet west of the Ontario Apartment House. Owing to the rapid growth of the city to the northwest, street improvements and building operations near the observing huts began in 1910 to threaten seriously the satisfactory continuance of the observational and experimental work. The construction work in the instrument shop was also seriously hampered because of crowded quarters, somewhat unsatisfactory lighting, and the necessarily temporary installation of machinery in a large building primarily intended for residential purposes. By this time also the progress made by the Department had brought it to a point where the successful and complete solution of the problems of the Earth's magnetism, and allied subjects, called for a combination of laboratory experimental work with the purely observational work.

Because of the lack of the necessary laboratory facilities, the work hitherto conducted in the subjects of terrestrial magnetism and terrestrial electricity has been chiefly observational. Thus we have magnetic or electric surveys, which imply the determination of the magnetic and electric elements at suitably distributed points over the Earth, with the view of obtaining, as accurately as possible, a knowledge of the Earth's general magnetic or electric condition. Furthermore, at a considerably smaller number of points, there are observatories which register the variations to which the magnetic and electric elements are subject, together with time and with varying planetary and solar conditions. There are thus in progress magnetic and electric surveys, and in operation magnetic and electric observatories; but no laboratory had as yet been established for the specific purpose of broad, cosmophysical research along both theoretical and experimental lines. The great need of the same happy combination of observational and laboratory facilities which had already proved successful in other sciences, as in astrophysics for example, thus became manifest. Besides the further improvement and refinement of the instrumental appliances for the observational work, there are manifold problems of fundamental importance open to such a laboratory, if properly manned and equipped.

The necessity for permanent quarters was further emphasized by the need of better facilities for the office work and for the work of the investigational staff, as also of fireproof archives for the storage of the accumulated field records and compilations of observational data.

With these aims in view, the Trustees of the Carnegie Institution of Washington made special allotments during 1913 and 1914, amounting to $127,200, to provide the requisite permanent facilities for the investigational work at Washington of the Department of

Terrestrial Magnetism, in accordance with plans submitted by the Director. These plans made provision for the following:

(1) A site of somewhat over 7 acres, admirably located amidst rural surroundings, in the District of Columbia, in close proximity to the extensive National Rock Creek Park, and sufficiently removed from industrial disturbing influences (Fig. 1).

(2) A commodious fireproof building, solidly built, of reinforced concrete and brick construction, containing the Director's headquarters and working rooms for the staff, library and archives, physical laboratory, instrument shop, testing-rooms, and certain observational facilities. This main building consists of a sub-basement, a basement, two floors, a spacious and well-lighted attic, and a specially constructed roof with observation-deck. It is 102 feet long, 52 feet wide, 49 feet from the ground to the roof, and 62 feet from the foundations of the sub-basement to the roof. Its erection was begun in May 1913 and it was completed on February 14, 1914. (Plates 1 and 8.)

(3) A one-story non-magnetic building (standardizing magnetic observatory), about 28 feet wide and 58 feet long, erected during 1914, to provide the necessary facilities for tests and researches requiring a non-magnetic structure (Plate 8). This observatory is sufficiently removed from the main building to be practically beyond its disturbing influence.

(4) Two or three smaller or accessory structures for special investigations in atmospheric electricity and allied subjects, to be erected in 1915.

Thus, the Department of Terrestrial Magnetism now possesses exceptional facilities for its varied work, both in the field and in the laboratory, in magnetism, electricity, and, to a certain extent also, in gravity. These three broad subjects appear more or less interrelated, and it is exceedingly difficult, even if that were desirable or worth while, to draw sharp lines of demarcation between them, or between distinctive laboratory problems and those of Nature at large.

SITE.

The site which most nearly met the requirements, and which, after considerable search, was finally selected, is a tract of land of about 7.4 acres at 36th Street and Broad Branch Road, Washington, D. C., in close proximity to the extensive National Rock Creek Park. It is on about the center line of the northwest portion of the District of Columbia, approximately a mile southeast of the northwest boundary line of the District, about 3 miles almost due north of the United States Naval Observatory, and about 1 mile north of the United States Bureau of Standards and the Geophysical Laboratory of the Carnegie Institution of Washington. The nearest electric car-line is about 2,100 feet to the west of the site. While this distance would be insufficient were it the intention, which it is not, to register at the site the variations of the Earth's magnetism, tests have shown that the distance is ample for the proposed testing and standardizing of magnetic instruments. Furthermore, this car-line will ultimately be converted into a sub-surface insulated system and hence the limiting distance of disturbance effects will be still further reduced. As will be seen by reference to the map (Fig. 1), the site is so surrounded by streets, gullies, and hills as to give reasonable assurance that it will answer the purposes for some time to come. The general distribution of the Earth's magnetism in Washington and vicinity is generally found to be somewhat irregular, but, for the site selected, it is practically uniform.

The area of the tract, as has been said, is about 7.4 acres; its elevation above mean sea-level varies with the topography from about 207 to 280 feet. It has a commanding view in all directions over a rolling country. The geographical position is 38° 57′ 24″ north latitude and 77° 03′ 52″ west longitude.

The purchase of the main tract was concluded on April 15, 1913, and in 1914 a small additional tract was purchased. Two dwelling-houses, which were on the site, have been

removed to provide the requisite space. Because of the topography and the desirability of easy approach to the main building, a considerable amount of grading was necessary. About 5,000 cubic yards of earth were moved in the preliminary grading and in the construction of the roadway into the grounds. On May 1, 1913, the contractor began the building operations.

MAIN BUILDING (HEADQUARTERS AND LABORATORY).

After careful consideration, the location of the main building on the acquired tract was chosen, as shown on Figure 1. The selection was governed partly by the requirement that this main building, in the construction of which considerable iron would enter, be sufficiently removed from the magnetic observatory so as not to cause serious disturbing effects. A sufficient area for other proposed experimental work also had to be allowed for.

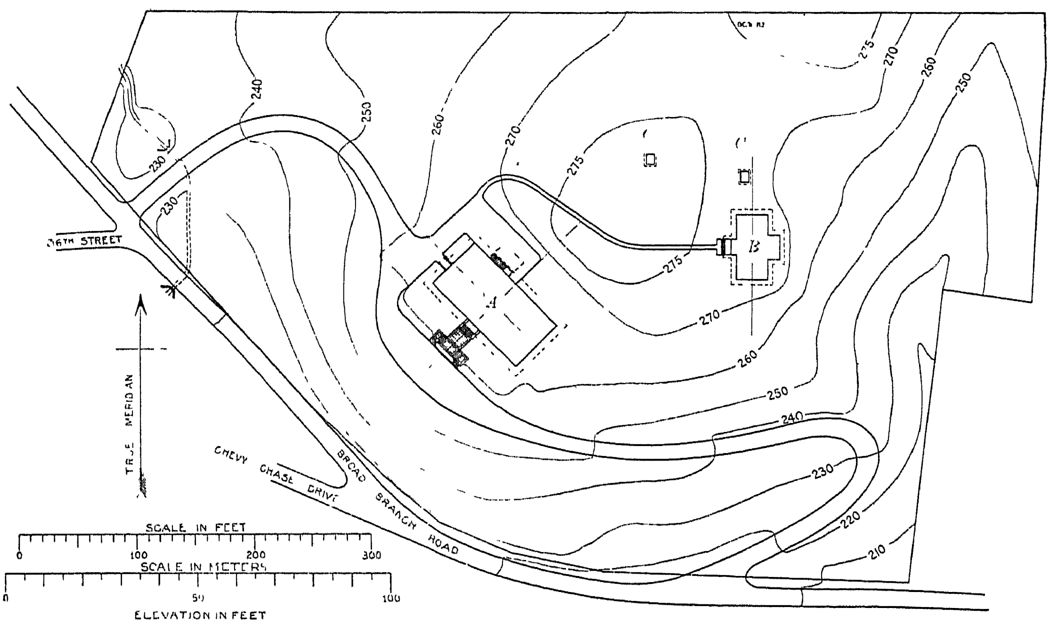


FIG. 1.—Plan of Grounds and Contour Lines
A. Main building.
B. Standardizing Magnetic Observatory
C Accessory buildings.

Before employing an architect a careful investigation was made of the requirements for the building, and preliminary drawings were made. The plans of twelve recently constructed physical laboratories were carefully studied, blue prints, specifications, and other necessary information having been courteously supplied by the various directors, to whom we wish to acknowledge our indebtedness. A detailed study was also made of the laboratories and research buildings constructed by other Departments of the Carnegie Institution of Washington: the office and shop of the Mount Wilson Solar Observatory at Pasadena, California; the laboratory of the Department of Experimental Evolution at Cold Spring Harbor, New York; the Nutrition Laboratory at Boston, Massachusetts; and the Geophysical Laboratory at Washington, D. C.

Upon the completion of these preliminary studies, it was possible to submit to a professional architect definite ideas and fairly complete sketches. Mr. Waddy B. Wood, of Washington, D. C., in view of his experience in the designing and building of two of the

laboratories in Washington, was employed by the Institution as architect. The general conditions set for the building were structural strength and solidity, greatest possible freedom from vibration effects, and maximum efficiency and utility for the purposes intended. Accordingly special care was bestowed by Mr. Wood on the numerous drawings required and in the formulation of the specifications. Messrs. Mechlin and Starr, of Washington, D. C., were employed by him to look after the engineering details. As the result of the cooperative work between the Department and the architect, a building of substantial construction and pleasing appearance, fulfilling adequately the varied and rigid requirements, has been obtained at a minimum cost.

On the basis of satisfactory competitive bids received, a contract was immediately entered into, on April 29, 1913, with the lowest bidder, the Davis Construction Company, of Washington, D. C. The work of construction was begun early in May 1913, and the building was completed, and ready for occupancy, on February 14, 1914. The *net cost*, including the heating, plumbing, and electrical work, and architect's fees, but not including any of the equipment, was in round numbers $68,000. The cost per unit volume was accordingly about 24 cents per cubic foot. We take this occasion to express our obligation both to the architect and to the contracting firm for the very satisfactory manner in which the tasks intrusted to them were executed. Throughout the erection of the building, Mr. J. A. Fleming represented the Carnegie Institution of Washington and the Department of Terrestrial Magnetism as supervisor of construction.

The *style of architecture* is on the lines of the Italian Renaissance. Facing the southwest, the building commands a beautiful view of the surrounding country, across a driveway leading to the National Rock Creek Park, and is said to present an appearance of strength and character in keeping with its destined use. Its outside dimensions are: length, 102 feet; width, 52 feet; and height, from grade level to top of roof, 49 feet. The exterior walls are of gray brick, yellow-brown in tone and of the rough wire-cut type, in random distribution of four shades, with raked-out joints five-eighths inch thick sunk one-half inch below the face of brick. At the grade level is a heavy granite course with six-cut hammered surface and vertical tooled cutting; at the first story and at the attic levels are rubbed-finish Indiana limestone courses, with a broad band of pebble-dash stucco work just above the upper limestone course and extending between the small lookouts under the eaves.

The entrance detail is worked out in Indiana limestone. (See Plate 8 and Figure 2.) Four marble insets, showing the cardinal points and fleur-de-lis of a conventional compass, have been placed around the window in the entrance arch. The approach to the entrance from the roadway platform is by a double flight of steps of Indiana limestone, with platforms of vitrified red brick laid on edge in pattern. The windows are of the casement type opening out, each window with a transom above; the glazing is of plate glass throughout. The roof, of dark-red Roman tile, has an unusually wide overhang. Two ornamental iron balconies have been placed on the southwest side and afford fine views, besides adding to the appearance of the building. The color scheme was carefully studied and planned to give the desired expression and to prevent the monotonous appearance frequently encountered in brick structures.

The *foundation-footings* are concrete, 12 inches thick and 3 feet 1 inch wide, resting upon clay subsoil. A test load of 6 tons to the square foot was made and the clay base found satisfactory. All walls below grade-level and the entire sub-basement floor were carefully waterproofed and dry-drained. The waterproofing consists of a heavy coat of pitch covered by layers of felt laid in pitch in successive layers, each lapping 6 inches. Wherever pipes pass through the waterproofing, copper gaskets and flanges are soldered to them and pitched into the felt. The exterior walls and the walls of the sub-basement below grade, in addition to the waterproofing, are parged on the outside with five-eighths

inch thickness of cement mortar in the proportion of 1 part of cement to 3 of sand. The walls are of best hard-burned brick laid with shove-joint in cement mortar which is in the proportion of 1 part of fresh Portland cement, with 10 per cent of hydrated lime paste added, to 3 parts of sand. Every sixth course is bonded with headers. This type of wall was adopted because it gives the greatest stability and solidity. All the stone-work is

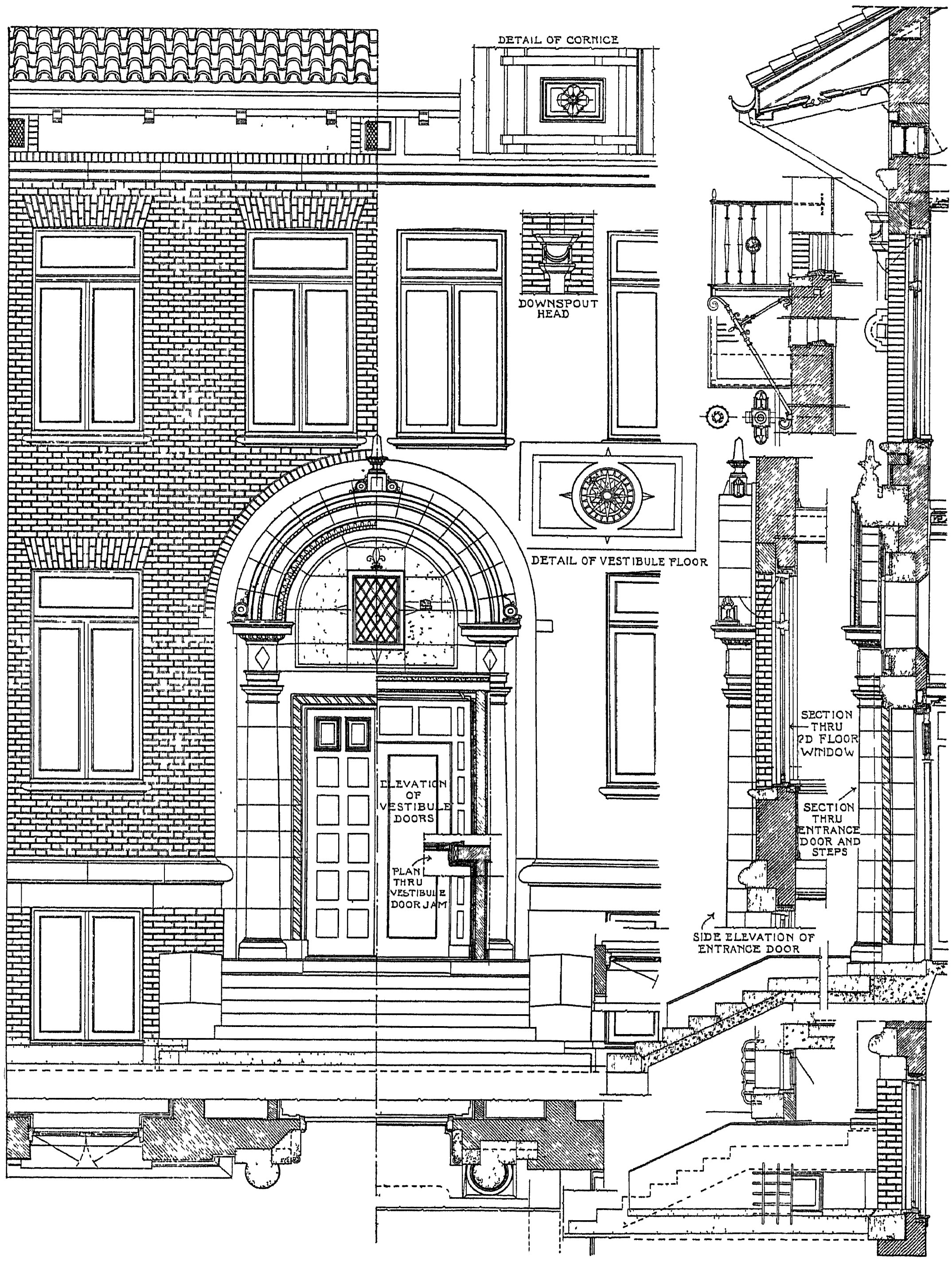


FIG 2 —Details of Front Entrance to Main Building

carefully and securely anchored into the brickwork by galvanized-iron anchors. The exterior brick walls to the height of the granite course are 22 inches thick; above the granite course to the roof-level they are 18 inches thick. For the purpose of stiffening the building there are three interior 13-inch brick walls carried continuously from the basement to the attic, two of these being transverse walls, one each about 18 feet from the ends, and the third along the center line between these two transverse walls. All of the partitions in the sub-basement, basement, and first floor are of brick and 13 inches thick, except for a few hollow terra-cotta tile partitions on the first floor. Except for the brick strengthening and corridor walls the partitions on the second floor are all of hollow terra-cotta tile laid in cement mortar.

The *floor-work* throughout the building is of hollow-tile reinforced concrete construction. This form was adopted in preference to structural steel because of its greater economy and the greater solidity and stiffness ensuing from its use. All cement was tested according to the standard specifications adopted by the American Society for Testing Materials.

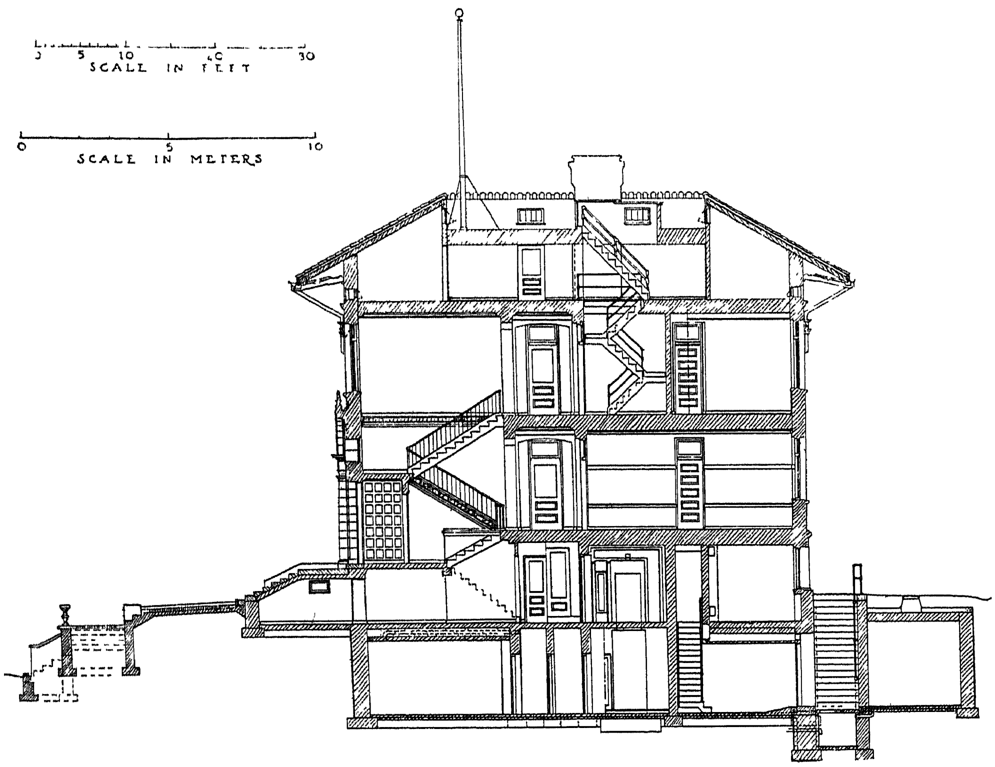


FIG. 3.—Transverse Section and Elevation of Main Building.

The proportions used for the concrete work were 1 of cement, 2 of sharp, coarse, clean sand, and 3 of clean gravel, with no piece larger than would pass through a 2-inch screen. The structural strength of the floors has been increased by a rather unusual method of construction, which involved the immediate laying of the finished cement surface at the same time that the floor itself was cast, thus increasing the structural depth by that of the cement filling. The topping was in proportion of 1 part cement to $2\frac{1}{2}$ parts of sand. In the usual construction the cinder filling, upon which the finished surface is made, is placed after the floor is set and thus adds nothing to the structural strength of the floor. The floors in all cases have been built as a part of the brick walls and have been anchored into them. The lintels over all of the openings are reinforced concrete and are cast with the floors. *The entire structure is thus practically monolithic and fireproof.* Corrugated-iron bars were used for the reinforcement. All floors are cement finished to a smooth surface with trowel except those in the lavatories, where 2-inch white hexagon tile set with close joints and sanitary tile base was used.

The building has six working levels (Figures 3 to 8): sub-basement, devoted to heating and gas-making room and to constant-temperature rooms; basement, devoted to instrument shops, several testing-rooms, storage-battery room, motor-generator room, and clock-room; first floor, devoted principally to laboratory rooms; second floor, devoted to Director's quarters, computing-rooms, library, and archives; a spacious and well-lighted attic for special laboratory work and storage purposes; and an observation deck

To overcome the transmission of vibration to the walls on which delicate instruments were to be mounted, the floors for all rooms in which it was expected that machinery of any kind would be placed have been built of concrete slabs 12 inches thick laid upon a cushion of sand 6 inches thick, and separated from the walls by 6 inches of sand on all sides. As it was not desirable to cut up the large instrument shop into two rooms, the wall between laboratory rooms Nos. 211 and 212 is carried by means of a heavily-reinforced concrete girder. To afford greater freedom from vibration the walls marked *A* on the plan of the first floor have been made entirely free of the reinforced-concrete floors. These walls also are discontinued a short distance below the ceiling of the laboratories and bear no loads from above. *Preliminary tests have indicated that even with all of the installed machinery in operation there is no vibration transmitted through the walls to interfere with readings of sensitive galvanometers.*

The *corridors* of the building are $12\frac{1}{2}$ feet high and, while not quite 7 feet wide, do not give the impression of narrowness, because of the arches across the width of the halls at each end and the dropping of the ceilings behind these arches. The doors leading to the various rooms from the corridors are all glazed with opaque rough "moss" glass. Some ornamental cornice plaster work occurs in the corridors, stair-hall, and in the Director's office. For the purpose of displaying a model of the non-magnetic survey yacht *Carnegie*, a concrete platform and die-block has been installed at the first floor level at the center of the stair-hall and immediately in front of the vestibule entrance.

A symbolic compass design, 25 inches in diameter and in relief in brass, is built in the marble and mosaic floor of the entrance vestibule. Its general detail is copied from an old compass card. The building being oriented with its long axis true northwest-southeast, the fleur-de-lis of this design is on a line at 45° with the axes of the building. The vestibule is paneled in cypress, finished in accord with the heavy $2\frac{1}{4}$-inch 12-paneled outside doors.

The wood-trim for all windows and doors throughout was reduced to a minimum in order to lessen possible fire risk; metal corner beads have been inserted at all plaster corners of the openings. The interior doors are $1\frac{3}{4}$ inches thick, 5-paneled "Korelok" with one-eighth-inch birch veneer and rubbed mahogany finish. The trim and window casements throughout are painted in a flat brown tint. The hardware is of brass with statuary bronze finish. All inside walls, except as otherwise noted, are finished in plaster.

There are but 5 observation piers; 2 of these are carried to the floor level of the basement, 2 are carried through the basement to the first-story rooms, Nos. 207 and 209, and 1 is carried from the sub-basement to the clock-room. All of these piers are built upon broad concrete footing-courses laid upon sand cushions and separated from the floors by sand on all sides. The piers in the adjusting-room are an integral part of the large concrete slab forming the floor of this room. The practice of building a great many piers has been practically discontinued in recently built laboratories, as, with solid construction, the walls themselves offer equally good supports for delicate instruments, particularly so when reasonable precautions are taken to prevent transmission to the walls of vibration from machinery in operation. There is also thus avoided the difficulty, often encountered where very high piers must be built, of flexure, and the magnification of any vibration due to height.

The *power* for lighting, and for use in the shop and in the laboratory, is supplied by the local electric power company, being delivered on the site at 2,300 volts, single-phase, alternating current, and transformed by a 25-kilovolt-ampere transformer, installed in the

building, to 220 volts. The power and light circuits are metered separately. The separate motor drives are economical, and the elimination of an engineering force that would be required in connection with the development of our own power effects a considerable economy in expense of maintenance. The lighting of the building is on 3-wire 110-volt alternating-current circuits and is controlled from panel-boards mounted in iron boxes, as indicated on the plans. Light fixtures are all of brass with statuary bronze finish to match the hardware. Doric moonstone glassware is used throughout, except for several special fixtures of Alba glass. All rooms, depending on size, have 2-, 3-, or 4-light pendant fixtures, using 25-watt lamps for each light, and 1 or 2 side-light brackets; the larger rooms are provided with two 3-light pendant fixtures. Each pendant light fixture is provided with an outlet at the center of the body, from which may be taken current for desk lamps or special experimental work. The corridors, shop, and furnace-room are lighted with half-bowl ceiling lights using 40-watt units. The main stair-hall is lighted by a special fixture, a glass globe 16 inches in diameter with the lines of the continents cut deeply in the glass, and containing eight 40-watt lamps, the whole being suspended by a heavy bronze chain. The outside entrance lighting is obtained from two heavy bracket lights in iron of fine detail.

The *heating* of the building is effected by a one-pipe, gravity-return, low-pressure steam system; two radiators are provided in each of those rooms most exposed, to control more effectively the heating during milder seasons by using only one radiator. The heater has a capacity of 3,150 square feet of radiation. All exposed pipes in basement and sub-basement are covered with 85 per cent carbonate of magnesia cover bound in canvas with brass straps and well painted. The radiators are plain cast iron 2-column type, 26 inches high. Outside of the special ventilation provided for the storage battery, clock, lacquering, soldering, constant-temperature, and chemical-laboratory rooms, and the entry hall to the storage-battery room, there is no forced ventilation. The rooms will at no time be crowded and ample ventilation under this condition is afforded by use of transoms over the outside windows and over intercommunicating doors.

The *floor covering* generally used throughout the building is linoleum three-sixteenths inch thick. The entire back of the linoleum was cemented, with a special glue, to the floor and fastened down as soon as it was cut; it was then rolled with a heavy roller weighing about 150 pounds, and the joints were further weighted down, after rolling, with long, slender sandbags, until the glue was thoroughly set. This question of floor covering was one upon which there seemed to be much diversity of opinion, but the linoleum covering as applied and in place for about nine months has been found to be extremely satisfactory in the office rooms, in the laboratory rooms, and in the shop, where it is subjected to particularly hard wear. It is a very sanitary floor covering, is easily kept clean, and, being elastic, eliminates the objection of the tiring effect resulting from standing any length of time on inelastic cement floors. There has been no trouble with expansion and contraction of the linoleum. Special care was used in laying it and in detailing the baseboard and trim to cover the edges at walls. For the floors not so covered in the attic, in three of the basement rooms, and in the sub-basement, the cement surface was painted with two coats of a cement filler to prevent "dusting," a frequent source of annoyance.

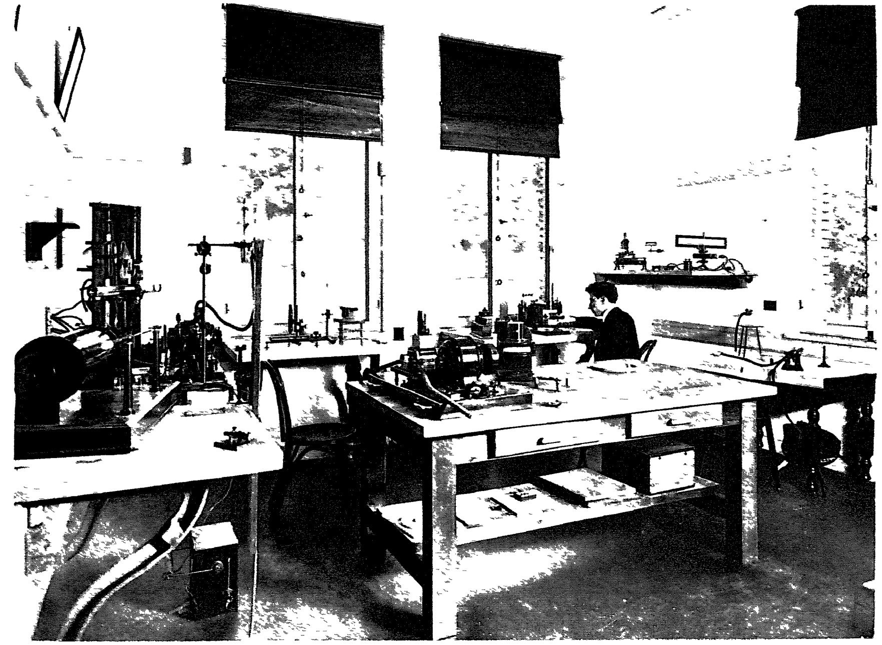
The *stairs* throughout the building are either of iron or iron with slate treads. It was decided not to use concrete for stair work because of the frequent difficulty experienced with "dusting," and the "crazing" of the cement surface, which results in a rather unsightly appearance. For the main stairs, black slate treads have been used; the slate platform is in two colors, the border being the same as the treads and the insert of a greenish tone.

Communication between the various rooms and with the outside telephone-service is accomplished through an interphone system, made by the Western Electric Company and consisting of 14 instruments installed by the local telephone company in conduits running through the building. The two trunk lines of the telephone company are brought in through an underground conduit.

PLATE 9

1

2



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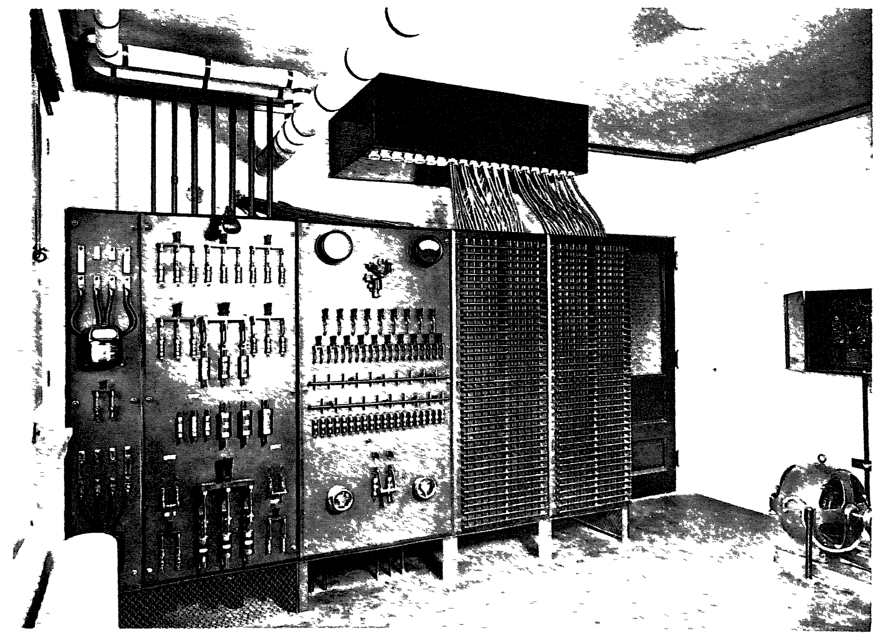

4

Interior Views of Main Building (Headquarters and Laboratory).

1 Library and lecture room.
2. East laboratory room.
3. General instrument shop
4. Switchboard.

The *plumbing arrangements* are exceptionally complete. Enameled-iron sinks with hot and cold water are installed in all laboratory rooms and where needed in the shop rooms and elsewhere. The lavatories are finished in white marble, with complete appointments and shower baths. All fixtures are back-vented. A gas connection is in general supplied to one wall-bracket in each room for use when, for any reason, there is an interruption in the electric power supply. All exposed water pipes in the basement and sub-basement are covered with five-eighths inch felt covering wrapped in a double thickness of canvas and bound with brass bands.

No special provisions were made for protection against lightning; the copper sheathing surrounding the edge of the observation deck, and the numerous vent pipes, are deemed sufficient protection.

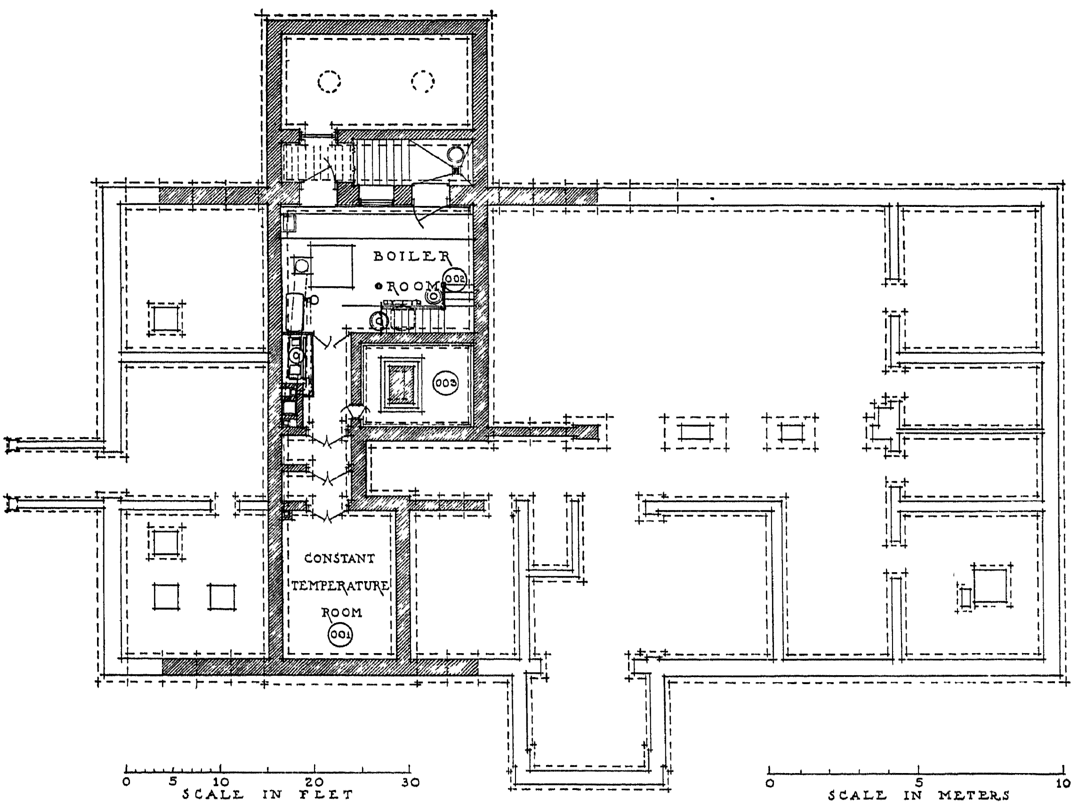

FIG. 4 —Plan of Sub-basement of Main Building

The *sub-basement walls* (Fig. 4) are unplastered, except for the constant-temperature room, the brickwork being finished with struck joints and painted cream white with water color. The room for the heating plant is supplemented by a coal vault having a capacity of 50 tons, which extends to the rear under the roadway, and is provided with two manholes for receiving the coal; the floor is slightly above the level of the furnace-room. The city coal-gas not being available, it was necessary to install a gasoline gas-generator in the furnace-room, with an underground gasoline reservoir placed outside. This room also contains the hot-water heater of 150 gallons capacity and the hot-water storage 100-gallon tank for supplying hot water to all sinks and lavatories. A stationary vacuum-cleaner and motor, with outlets in various parts of the building, is mounted in the first vestibule to the large constant-temperature room. The latter room, No. 001, is surrounded by earth on all sides except for the space required by the entrance vestibules, of which there are 3. To prevent dampness every precaution was taken to have effective ventilation; the supply

of air is through the entrance vestibules and the outlet by a special flue to the chimney-cap 50 feet above. A second room is also available in the space below the clock-room for work requiring constant temperatures; it is thoroughly insulated by 13-inch brick walls on the sides, lined with 3-inch hollow terra-cotta tile set in cement mortar, and these in turn plastered over with three-fourths inch of plaster. The lower portion of the clock-pier passing through this room serves for mounting any stationary apparatus.

On the *basement floor* (Fig. 5) there is provision for a large instrument shop, dividing-engine room, the woodworking shop, adjusting-room, and rooms for lacquering and soldering, the two latter being provided with adequate means for ventilation to the roof. All of the walls, except those of the lacquering, soldering, dividing-engine, and clock rooms, are unplastered, the brick work being painted cream white with water color. Great care was used in all shop rooms not to have the work-benches in contact with the walls. Each work-bench is

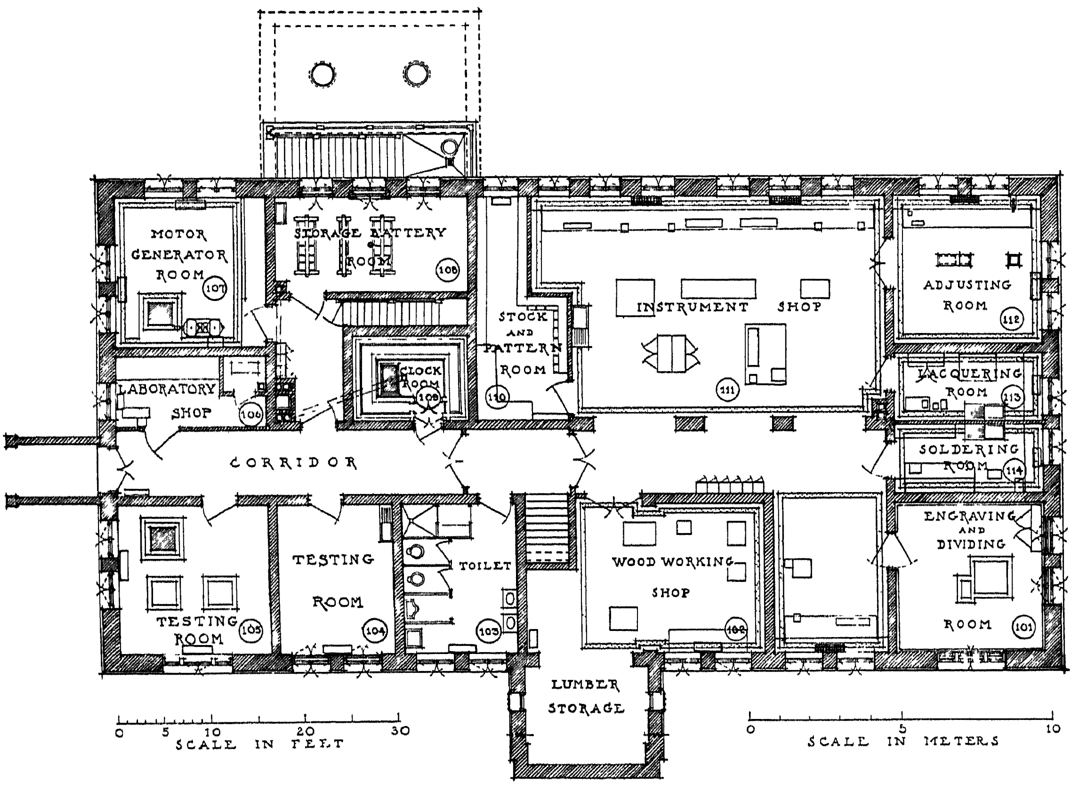

FIG. 5.—Plan of Basement of Main Building.

placed near a window and is supported not from the main wall, but from a reinforced-concrete wall which is a part of the sand-cushioned concrete floor. The reinforced-concrete walls do not appear in the shop photographs (Plate 9), as they are hidden by shelving which is utilized for storage of tools, etc.; the benches and shelving are so fastened that at no place is there possibility of contact from one to the other. The dividing-engine room is practically a constant-temperature room; the walls are lined with hollow terra-cotta tile laid in cement and plastered; all windows and doors are double. Special electric circuits and outlets are provided in all the walls for uniform distribution of heating and illumination. The dividing-engine and its motor are separately mounted on massive concrete piers built on 18-inch sand-cushions. The tool equipment of the instrument shop is quite complete, including universal milling machine, 16-inch engine lathe, 8-inch precision lathe, 3 bench lathes, small Auerbach lathe, watchmaker's lathe, drill press, planer, dividing-engine for dividing

circles up to 1 meter in diameter, engraving machine, lacquering outfit including air compressor and oven, grinder, circular saw-table, wood-trimmer, disk-sander, band-saw, forge, bench tools, and a full equipment of small tools for metal and wood working. Each of the machine tools is operated by an independent motor on 110- or 220-volt alternating single-phase current. The basement contains also a small shop for the special use of the laboratory, and is fully equipped with work-bench, 9-inch lathe, and small tools. There are also on the basement floor 2 rooms in the west corner for special instrumental work and testing purposes, and the lavatory and shower bath.

The *clock-room* is advantageously located for constant-temperature conditions, being practically at the center of the building and surrounded on all sides by heavy 13-inch brick walls and special insulating and ventilating arrangements.

The *storage-battery room* is isolated completely from all other rooms of the basement by an entry hall. A ventilation duct is provided to the chimney stack, where a special fan, operated from the storage-battery room, is mounted to increase the ventilation as necessary. As this room is directly above the furnace-room, an air space was interposed between the ceiling of the furnace-room and the floor of the storage-battery room to prevent too high or sudden fluctuations in temperature. This air space is connected directly with the outside by ventilating shutters placed above the door and window of the furnace-room. A great deal of attention was given to the question of acid-proofing of floors of battery-rooms and a number of plans and details were studied. It was decided that for so small an equipment the most economical and satisfactory arrangement would be a floor of vitrified brick laid on edge in cement mortar with close joints over the reinforced-concrete floor. This brick floor is built with a fall from all sides to a drain at the center, and a sump pit provided in the outside area below for the dilution of acid waste in case of an accident. The walls of the room are also of vitrified brick laid up in cement with close joints. All of the exposed metal work has been painted with a specially prepared acid-proof paint, and special acid-proof lighting fixtures and switches were installed. All metal work will be further protected by a coating of paraffin.

The present *storage-battery equipment* consists of 60 chloride accumulators of type E13 by the Electric Storage Battery Company, having the rated capacity of 30 amperes at the 8-hour discharge rate of 240 ampere-hours. The equipment is mounted on 3 wood frames in two tiers, one above the other, each tier containing 30 cells. Each set of 30 cells is subdivided into 2 groups of 3 cells, 2 groups of 6 cells, and 1 group of 12 cells. The leads to and from the room containing the motor-generator and switchboard are of No. 4 gage copper wire lead-covered.

The equipment for the *motor-generator* and switchboard is in the north corner of the building, adjacent to the storage-battery room. The motor-generator set consists of a 10-horsepower, 60-cycle, single-phase, 220-volt motor of the Wagner type, mounted on a single base with, and coupled to, a 5.4 kilowatt, 90-volt, shunt-wound direct-current generator of the Crocker-Wheeler type.

The 5 *switchboards* are of slate. On the first are mounted the alternating power and light meters, together with test links. The second board controls the alternating-current supply. It comprises, in the first place, 2 rows each containing 3 switches. The upper row controls the lighting system for the basement, first floor, and second floor; the lower row controls the power supply to the power panel-boards, workshops, and laboratories. Four additional switches are provided besides the main switch, 2 for the roof fans, 1 for the stereopticon, and 1 for the vacuum-cleaner. The last 3 boards together comprise respectively the charging-board, the positive distributing-panel, and the negative distributing-panel for the storage battery. In the design of these boards, Dr. W. F. G. Swann, chief physicist, followed somewhat, in the case of the distributing-panels, the plan adopted at the Ryerson Physical Laboratory of the University of Chicago.

The charging-board is shown to the left of Figure 4 of Plate 9. The 2 horizontal bus-bars in the center of the photograph are connected through the ammeter, circuit-breaker, and charging-rheostat to the charging-switch at the bottom of the figure. The voltmeter is, of course, connected to the bus-bars. The short vertical bars are connected to the terminals of the groups of cells above referred to and to the double-pole switches shown. The latter serve to connect or to disconnect them from the corresponding vertical bars of the distributing-panel. The single-pole switches are for throwing the groups in series, and it will readily be seen that a large number of arrangements of the cells may be made in series or in parallel, both for the purposes of charging and distribution. Further, by a suitable combination, voltages may be obtained in multiples of 6 ranging from 0 to 120 volts. The fact that the groups may be entirely disconnected from each other is of advantage in

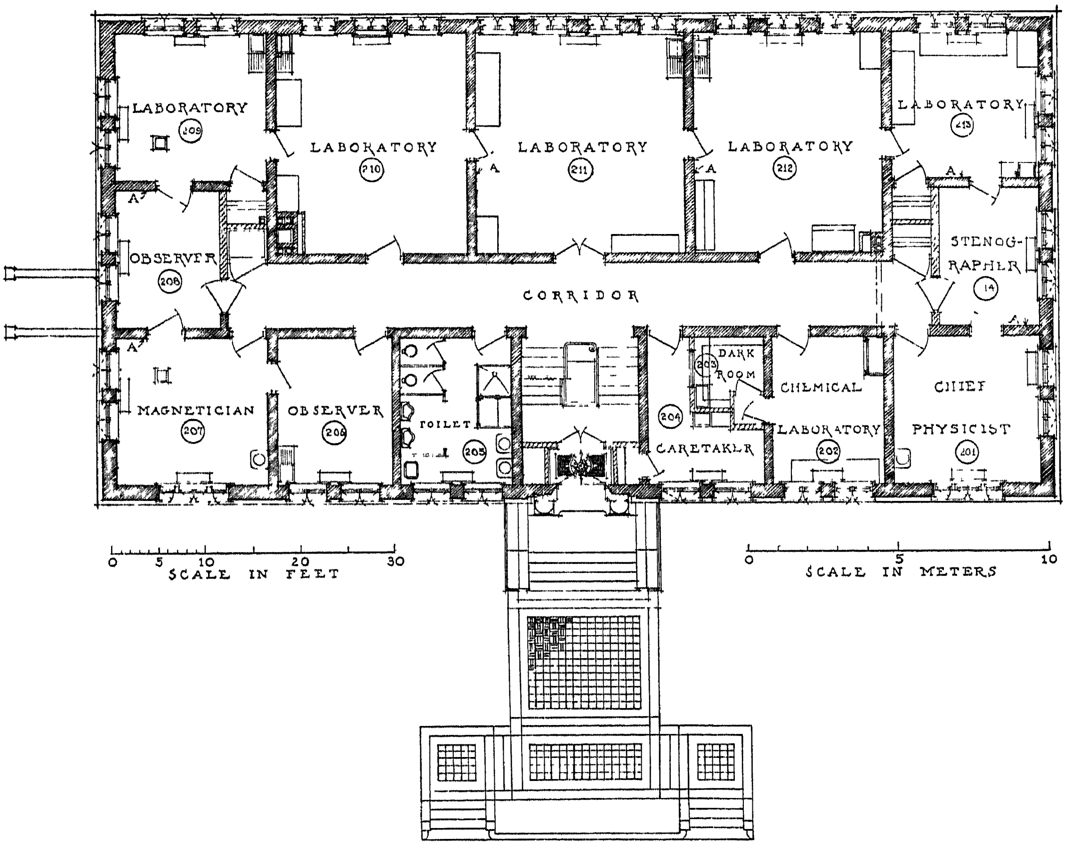

FIG 6.—Plan of First Floor of Main Building.

enabling them to be used entirely independently; thus, two different portions of the battery may, for example, be used simultaneously, each having an earthed terminal. The horizontal bars of the distributing-panels are, of course, joined to the laboratory conduits, and suitable connections are provided for connecting them to the appropriate vertical bars. The motor-generator is designed so that by the field control alone a stable voltage range is possible from 90 to 60 volts. This enables the two 30-cell batteries to be charged in parallel without waste of power in the charging-rheostat.

The *first floor* (Fig. 6) is devoted primarily to the experimental work of the laboratory. There are 3 large laboratory rooms, 2 small laboratory rooms, chief physicist's room, chemical laboratory, and dark room. Each of these is provided with hot and cold water and a number of dust-proof power receptacles 3 feet 6 inches above the floor for alternating

current at 110 volts; they have also from 1 to 4 special outlets for direct-current circuits from the storage-battery room, and from 1 to 4 gas outlets. There are likewise on this floor 3 rooms for the use of observers and 1 small room for the caretaker of the building. The detail of the window openings in the laboratory rooms is designed to provide light-proof curtains for darkening the rooms for special experimental work. The only piers carried to the first story are those in rooms Nos. 207 and 209; they are of course free from the floor. Below the floor they are 3 by 3 feet to the concrete footing and $12\frac{1}{2}$ inches square from just below the floor; the top sections are of hydraulic white brick surmounted by white marb e caps 2 inches thick and 16 inches square placed 3 feet above the floor. These piers are so aligned with windows and doors that from the one in room No. 209 it is possible to sight through the building either on the northwest-southeast line or the northeast-southwest line and from that in room No. 207, on the northeast-southwest line and to the northwest.

In order to give the greatest possible freedom in the experimental work, from 1 to 4 special three-fourths-inch conduits with two 8-gage wires each are installed from the

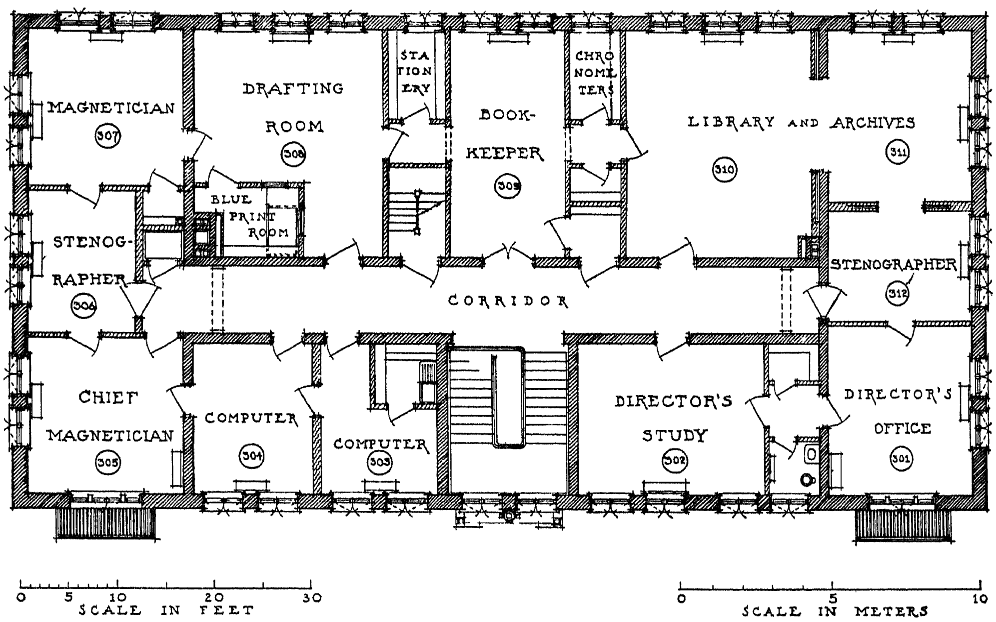

FIG 7—Plan of Second Floor of Main Building.

switchboard to each room. Conduit connections are inserted in the walls between the rooms to provide for clock and other circuits. As already stated, the distributing-switchboard for the storage battery is so arranged that various combinations can be secured in any one of the rooms independently of any other. Small special soapstone switchboards are provided in each room at the special circuit outlet boxes to make possible additional combinations. Each room is supplied with a heavy oak hook rail just below the ceiling. This is intended for the stretching of fine piano wire from side to side to support special overhead wiring and appurtenances. In each room, 7 feet above the floor, a 4-inch wooden rail is securely fastened to the walls for mounting light lead-wires and galvanometers; vertical wooden strips, 28 inches long, are placed in some of the rooms and extend down from this rail; on these strips may be mounted movable and adjustable shelves for the lighter apparatus. A 6-inch molded table-rail at the height of 33 inches has been added throughout this floor. For mounting the heavier instruments, or those requiring great stability of bearing, such as balances, heavy cast-iron brackets are attached to the walls by expansion bolts and on

these brackets are laid soapstone slabs, $1\frac{1}{2}$ and 2 inches thick. A number of 2-inch soapstone slabs are mounted on stands made of $1\frac{1}{4}$-inch pipe; these have the advantage that they may be moved about. The equipment also includes substantial wooden tables, manufactured by the Kewaunee Manufacturing Company, with 4-inch square legs and $1\frac{3}{4}$-inch tops of birch made of strips specially tongued and glued together; these tables are in 2 sizes, 33 by 60 inches and 42 by 72 inches. Some of the bracket slab-tops are 36 inches and some, particularly those for galvanometers, are 4 feet 6 inches above the floor; the wooden tables are 33 inches in height, and the soapstone tables on pipe stands, 36 inches.

The chemical laboratory is fitted with a bracket stone slab extending in front of the windows. A special ventilation duct to the roof with exhaust fan is provided for a hood of the usual sliding-door type; to the hood has been added a special compartment for charging portable storage batteries. The chemical table is furnished with sink, racks for reagents, drawers, cupboards, and special storage place for glass rods and tubes. The dark room

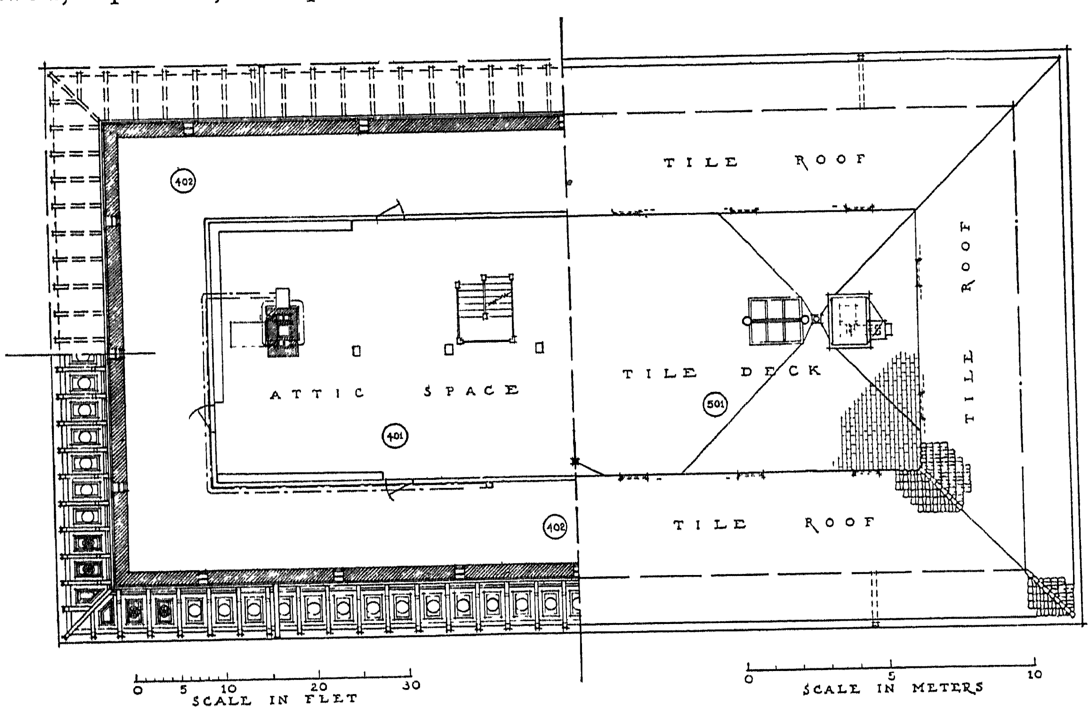

FIG. 8.—Plan of Attic and Roof of Main Building.

adjoins the chemical laboratory and is entered by two doors and a vestibule. A soapstone sink with long soapstone drain-board is provided, together with special direct-current, alternating-current, and gas outlets.

The *second floor* (Fig. 7) is devoted entirely to the Director's headquarters, working rooms for the staff, and library and archives. Provision has also been made for drafting and blueprint rooms, and for a kitchenette in room No. 303 for the use of the staff and occasional use when meetings are held in the building. The two library rooms are connected by a large double sliding-door, so that they may be used practically as one room 37 feet long and 24 feet wide. A special conduit and connections are installed for a stereopticon. The records are filed in special vertical file cases to facilitate rapid reference.

The central portion of the *attic space* (Fig. 8), with a clear ceiling height of 7 feet 2 inches, is 79 feet long and 29 feet wide; this space is lighted by means of 2 skylights and 2 windows in the hatchway leading to the observation deck above, and being plastered furnishes an excellent place for storage and for certain experimental work. There is no elevator,

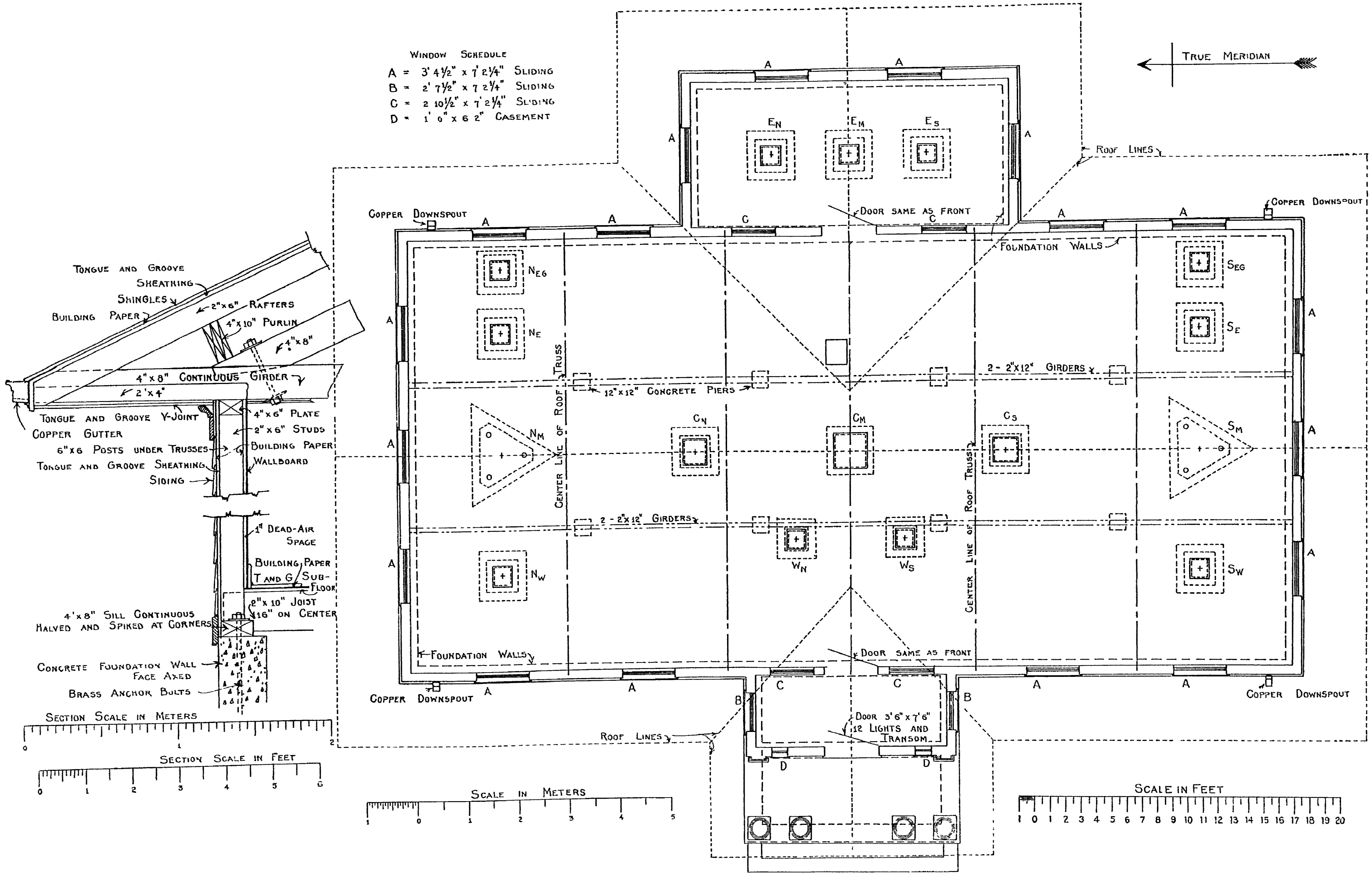

Fig 9 —Plan and Details of Standardizing Magnetic Observatory

but instead, a shaft from the basement to the attic on the south side of the main chimney, with doors at each level, serves for handling heavy apparatus with block and tackle. The space under the sloping roof is, at the apex of the roof, about 4 feet higher than the central attic-space, the roof having been carried up to form the sides around the observation deck. This space is 9 feet 5 inches wide and continuous around the entire building, being lighted by windows in the sides of the observation deck and by the small lookouts under the eaves. As the clear height of this space at the outside wall is 5 feet 6 inches, it is particularly valuable for storage purposes and for any special work requiring long sights or exceptional freedom from air-currents. This space is plastered with a rough sand brown coat, except for the struck-joint brickwork on the outer walls.

The *observation deck* (Fig. 8), 29 by 79 feet, is reached by an iron stairway and a hatchway with sliding top. The floor is of 6 by 9 by 1 inch red vitrified clay tile laid in cement grout over a thoroughly waterproofed reinforced-concrete floor. The sides of the deck are sheathed with 14-ounce copper to the roof-crest line. The ventilating and chimney stacks are 3 feet by 5 feet 2 inches in section and extend 8 feet above the deck, about 8 feet from each end, and have already been used as piers in atmospheric-electric work.

STANDARDIZING MAGNETIC OBSERVATORY.

There was no attempt made to provide a non-magnetic testing-room in the main research building. Instead an entirely separate and strictly non-magnetic structure to serve the purposes of a standardizing magnetic observatory has been erected, at a sufficient distance from the main building to be practically free from disturbance. (See Plate 8 and Fig. 9.)

The observatory is to the east of the main building, being over 150 feet distant at its nearest point. The general character of this structure, the design for which was developed by Mr. Fleming, and architecturally adapted by Mr. Wood, is in general harmony with the main building. Its outside dimensions are 28 feet by 58 feet, with a bay on the east side 21 feet 6 inches long by 9 feet 6 inches wide, and an entrance with vestibule and porch on the west side, 13 feet 6 inches by 10 feet; the ceiling height throughout is 12 feet. The roof overhangs 4 feet on all sides; the attic space is used only for ventilation purposes, being provided with open louvres at each end and in each gable. The windows have been made of the sliding-sash pattern rather than the casement, as this type seemed to offer some advantages for a building of this character, in which it is necessary to provide blinds that may be closed to protect the instruments from the Sun's glare. The windows are made unusually large to secure the best possible illumination. The considerations involved in the design have been primarily non-magnetic construction, and the placing under one roof of a number of observing piers sufficiently far apart so that several observers, without disturbance, can simultaneously standardize and test their instruments.

Naturally the observatory is built mainly of wood, this being practically the only non-magnetic building material that can be economically obtained. The foundation walls are of concrete, using Saylor's cement and selected sand and gravel, which, upon careful test, showed practically no magnetic properties. However, in order to guard against a disturbance on account of the mass of concrete used in the foundations, the floor is set considerably above the top of the foundation. All of the metal fastenings, flashing, sashweights, locks, other hardware and truss-tie members are of non-magnetic lead, copper, brass, or bronze.

The *piers*, as indicated on the plan of the building in Figure 9, are built of a special non-magnetic, steam-baked brick laid in a mortar of lime, cement, and a selected white non-magnetic sand. The 14 piers are built above the floor level to heights over all of 36, 42, 50, and 54 inches. For 9 of the piers, used primarily for field-instrument work, there are provided non-magnetic universal eccentric clamps for securing the instruments

on the pier-caps; these are operated by milled heads on shafts projecting from the sides of the pier, the mechanical details being built in with the brickwork. Suitable relief springs are provided with each clamp to insure no damage to the tribrach bases of instruments in case the clamp is set too far down. There are also 2 triangular piers, reaching almost to the floor joists, in each of which are built for mounting tripods 3 brass pipe-supports, each 3 feet long. The piers built above the floor will be used as mounts for earth inductors, galvanometers, magnetometers, and special electromagnetic instruments. The 3 piers in the bay are placed rather close together, to permit laying a stone slab across them for testing magnetographs.

The *heating* of the observatory will be by gas heaters of non-magnetic construction. The illumination will be by alternating electric-current and semi-indirect 200- and 100-watt lamps with floor outlets for special hand lights and connections. Special direct-current circuits will also be installed for experimental work.

In addition to the natural marks which are available for azimuth work, 3 piers with engraved glass windows and electric lighting for night use will be placed at the extreme north line of the property of the Department.

The interior of the observatory is lined with wall-board, no plaster being used; this gives a practically uniform insulation and will readily permit any future structural changes. The joints in the wall-board are covered with cypress battens to produce paneled effects both on the ceiling and the walls. The large ceiling is relieved of monotony by five false beams under the lower members of the trusses.

As it is desirable, in an observatory of this kind, to have a fairly constant temperature during the observational work, special provision was made against rapid changes of temperature. Thus the walls consist of the outside siding laid over heavy building paper, which in turn is placed on matched sheathing closely nailed on 2 by $5\frac{3}{4}$-inch studding, on the inside of which is placed with overlapping joints a layer of heavy building paper covered by 1-inch battens, on which the wall-board, about $\frac{3}{16}$ inch thick, is nailed, thus providing on all sides a 1-inch dead-air space. The floor of the building is double; the lower floor is 1 by 6-inch matched pine closely nailed, over which there is a layer of heavy building paper; the finished floor is of edge grain $\frac{13}{16}$ by $2\frac{1}{2}$ inch Georgia pine.

The construction of this building was undertaken by the Department, as it is difficult to get satisfactory bids on structures built of non-magnetic materials. In consequence the total cost was only $5,500, an average of about 14 cents per cubic foot of the total volume.

ACCESSORY STRUCTURES.

There are at present on the site, besides the main building and the standardizing magnetic observatory just described, two small non-magnetic huts which were formerly used for intercomparisons of magnetic instruments. They are now available for other purposes, as, for example, atmospheric-electric observations. For the latter work, furthermore, an isolated wooden tower, about 80 feet high, is to be erected in 1915, on the top of which a small hut for housing the atmospheric-electric instruments will be built.

MAGNETIC INSPECTION TRIP AND OBSERVATIONS DURING TOTAL SOLAR ECLIPSE OF APRIL 28, 1911, AT MANUA, SAMOA.[1]

By L. A. Bauer.

PURPOSE AND EQUIPMENT.

In 1911 I visited, *en route* to join the *Carnegie* at Colombo, Ceylon, various scientific institutions and magnetic observatories in the Orient and conferred with various persons respecting cooperative magnetic work. Leaving Washington, D. C., on March 16, 1911, I proceeded to Colombo via Vancouver, Honolulu, Suva, Auckland, Christchurch, Sydney, Melbourne, and Perth, being due at Colombo about the middle of June. According to the steamer schedules, I would have a wait of about three weeks at Suva, Fiji, before connections could be made for New Zealand.

A total eclipse of the Sun was to occur at certain places in the Pacific Ocean on April 28, 1911 (Plate 10, Fig. 2). All the observing parties, of which I had heard, had decided to congregate at various points in the Tonga Islands. The most important of these expeditions were those of the British and the Australian astronomers, which were exceedingly well equipped and for which most elaborate preparations had been made. So far as I knew, however, no party essayed reaching any other island, though by so doing the chances would be multiplied of getting results in case the parties in the Tongas were unfortunate as to weather. Consulting the time tables, I found that we were due at Suva, Fiji, on April 10, but 18 days before the eclipse and a week or more after the other parties would already have been engaged on the necessary preparatory work at their respective stations. At Suva, unfortunately, the eclipse was only to be a partial one and it would be necessary to travel almost 1,000 miles or more eastward to reach a desirable point.

As will be seen from Fig. 2 (Plate 10), the actual line of central eclipse commenced on the southeast portion of Australia, and passed in a northeast direction, crossing the equator in about longitude 154° W. It then swept eastward, terminating in about longitude 90° W. just off the west coast of Central America. The line thus extended over the full width of the Pacific Ocean. While there are many islands in this ocean, there were, unfortunately, remarkably few which lay in the narrow band of the totality track. Following the line from west to east, the first suitable station that one finds is Tofua, in the Tonga or Friendly Islands. The next that is met with is Vavau, in the same group, and also close to the central line of totality. Most of the eclipse parties were located near this station. Much farther eastward we reach Nassau, which lies a little to the south of the central line, but well within the central zone; and not far away are the Danger Islands, which are situated to the north, but farther away from the central line. To reach Nassau or Danger Islands would require a specially chartered steamer, and landings on them, on account of breakers, are not always possible. Manua Island, of the Samoan group, on the western edge of the belt, appeared to be the most feasible station in the east to make a try for within our limited time.

Inquiries made, however, both at Washington and Vancouver, had indicated that the chances were exceedingly small of connections being made at Suva with any vessel for the Samoan Islands whence I might proceed to the tentatively chosen eclipse station. It was, nevertheless, thought worth while to take along a limited equipment to be utilized in case I was fortunate enough in my connections. I was primarily interested in attempting once more to discover whether there was an appreciable effect on the Earth's magnetism during a total solar eclipse.[2] Stress was, accordingly, laid on the magnetic outfits, of

[1] A preliminary account was published in *Science*, July 28, 1911, p. 105

[2] For the results of previous work, see *Terr. Mag.*, vol. 5, 1900, pp. 143–165, vol. 7, 1902, pp. 155–192.

which two were taken to guard against possible accidents. These delicate instruments had to be transported from Washington about 8,000 miles, during which they would be subjected to all kinds of handling and of transportation; they, furthermore, had to be packed in water-tight tin cases, as landings on Manua Island can not always be effected on account of breakers, and so provision had to be made against possible upsets of the landing-boat.

In like manner was packed a double-barreled, hand-driven, equatorially-mounted camera of about 11.5-foot focus, hastily improvised for me through the kindness of the Director of the Astrophysical Observatory of the Smithsonian Institution, Mr. C. G. Abbot. The camera-tubes, for convenience, were made in three sections of stove-pipe and the tripod was constructed of gas-pipe. The whole was packed in three water-tight cases. The only valuable portion of the photographic outfit consisted of the two lenses,[1] which were to be brought back; the remainder of the apparatus could be left behind, if necessary. Mr. Abbot also kindly furnished the directions and program according to which photographs of the eclipse were to be taken if chance favored. These chances being so uncertain, I did not feel warranted in taking assistants with me, especially as, let it be recalled, my journey was for the purpose of joining the *Carnegie* at Colombo, Ceylon, and visiting certain institutions *en route*, and was not, in any sense, a special eclipse expedition. I had decided to make the attempt to observe the eclipse chiefly in order to put in the time profitably while awaiting the New Zealand steamer at Suva, Fiji, and thus to assist, if possible, in securing a desirable distribution of eclipse stations.

Even after Vancouver was left behind on March 24, it was still uncertain whether it would be my good fortune to observe the eclipse of April 28, now only a month distant. However, during a few hours' stop of my steamer at Honolulu on April 1, I learned of the possibility of catching a small steamer, the *Dorrigo*, chartered by the German Government to carry the mail from Suva to Apia. Arriving at Suva, 5 p. m., April 10, I found that the *Dorrigo* was in the harbor and was to leave within an hour or two for the Samoan Islands—just giving me time to post some mail, cable to Washington that connection had been made, and, with the friendly assistance of the Suva harbor-master, to get my numerous cases transhipped from the Canadian Pacific steamer *Moana* to the *Dorrigo*. There was one other passenger besides myself who was anxious to make this connection, a Mr. Boling, of Indianapolis, who had been appointed law clerk at the United States Naval Station, Pago Pago, Tutuila. He and I occupied the cabin forward, and the only other cabin—the one aft—was taken by three copra agents. The *Dorrigo* is a small steamer originally employed in river-work in Australia and hence not well adapted for ocean service; she proved herself quite a roller during our three days' stay aboard.

TRIP TO ECLIPSE STATION.

Apia, the seat of the German Government and the chief place in the Samoan Islands, was reached on the morning of April 13. It was confidently expected that some means would be found to cover the short stretch of about 85 miles from Apia to Pago Pago. The small steamers counted upon were not available, one, the *Dawn*, having left a few days previous, and the *Rob Roy* having been chartered by the German governor of Samoa. However, a freight steamer of the Weir line of San Francisco was expected in about a week and I was told that it would call at Pago Pago. It was forcibly impressed upon me, not only at this point but elsewhere on my trip, that distance is not to be measured in miles but by connections and the possible modes of travel. In the meanwhile arrangements were made at the Apia Geophysical Observatory for obtaining the corrections of my time-pieces on Greenwich mean time, as also for magnetic observations simultaneous with those to be

[1]They were the same as used by Mr. Abbot on Flint Island during the eclipse of 1907.

made at my eclipse station. The Acting Director, Dr. Hammer, besides rendering every possible assistance in these respects, was also able to give me valuable information regarding Manua Island. He told me that the Göttingen Academy of Sciences had planned to send an eclipse expedition to this island, and for this purpose a preliminary trip had been made there by Dr. Wegener and himself in a 30-ton motor boat, called the *Zeppelin*, a few months previous to my coming. The German expedition, for various reasons, had had to be given up.

I also learned through the United States consul at Apia, Mr. Mason Mitchell, of the possibility that the United States gunboat, the *Annapolis*, stationed at Pago Pago, might be put at my disposal. But in the absence of means of communication by steamer, cable, or wireless, it was not possible to communicate either with Pago Pago or with the United States Navy Department at Washington. However, preliminary arrangements were made for the charter of the small motor boat already mentioned, the *Zeppelin*, to take me and my outfit, if necessary, all the way to my destination, Manua Island, about 350 miles distant from Apia. I was advised, however, to await the possible arrival of the freighter and to resort to the motor boat only if necessary. So, having made all preparations possible, I accepted the kind invitation of Acting Governor Dr. Erich Schultz (now Governor) to accompany him, as one of his official guests, on a three-days' trip to the beautiful island of Savaii with its still active volcano, Matavanu, which was visited on April 16.

Returning to Apia on April 18, I began to get impatient, for the expected steamer was overdue and the eclipse was to occur the following week. When the steamer finally arrived on April 20, her date of departure, owing to difficulty in getting the necessary labor to discharge her cargo, could not be definitely fixed. So on Saturday at 5 p. m., April 22, in desperation, I left Apia, not on the freighter, but on the chartered motor boat, the *Zeppelin*, which was fitted out with a Diesel oil engine, said never to fail. Mr. Boling, being likewise anxious to get to his post, accepted my invitation to accompany me. As there was no cabin, we slept on deck, and since the trip to Pago Pago actually took 35 hours, instead of but 14 hours as expected, we were several times caught in drenching tropical rains. About 3 hours out from Apia the "infallible" engine began to miss fire and the pilot expressed a desire to return to Apia, to which proposition I refused, however, to yield. Hoisting sail, we got along the best we could for a while, but about 3 o'clock Sunday morning we were obliged to put in at a small harbor on the southeast coast of Upolo, the island on which Apia is located. After the engine had been taken completely apart it was found that the trouble lay not in it but in the oil supplied. So, after assembling the parts again, we put out to sea once more at 9 o'clock Sunday morning. We now had winds and currents against us and so managed to cover only about a mile an hour. Towards evening a gale sprang up, obliging us to make a long detour around the north and east coast of Tutuila, so that it was not until 4 o'clock the next morning, April 24, that we found ourselves safely anchored in the beautiful harbor of Pago Pago.

The United States gunboat *Annapolis* was found stationed here and, at the invitation of the officers, Mr. Boling and I took breakfast aboard. Commander W. M. Crose, at the time Governor of Tutuila, was seen shortly thereafter and the situation explained to him. He readily responded to my needs and agreed to transport me with my outfit to Manua Island on the *Annapolis* with the understanding that the vessel would return by Saturday morning, the day after the eclipse, as she was required for an official trip to Apia. Had there been more time, and if it had been absolutely sure that a landing could be effected, an island more centrally located in the eclipse belt would have been chosen, as, for example, Rose Island, Nassau, or Danger Island. At these islands the duration of totality would be between three and four minutes, whereas at Tau, on Manua Island, situated, as said, near the western edge of the belt, the duration was only about two minutes. Even at Tau, landings, on account of breakers, are not always certain.

The *Annapolis*, under the command of Lieutenant C. S. McDowell, left Pago Pago at 9 p.m., Tuesday, April 25, and after stopping the next morning at the islands of Ofoo and Oloosiga to pick up natives and Queen Vaitupu, in whose house we were to be quartered, we arrived at the northwest end of Manua Island at about 3 p. m., Wednesday, April 26, and anchored in Faleasau Bay. Lieutenant McDowell, who was to be my chief assistant, and I, with some others, landed at this point and went overland to the village Tau, 2 miles distant. The instruments were taken around the northwest coast in a boat and their safe landing through the breakers was intrusted to Captain Steffany, an experienced pilot in these waters. The remainder of the day was spent in selecting suitable stations and unpacking and assembling the instruments, which took almost until midnight. It was found that the instruments had sustained no injury during the long journey.

SOLAR OBSERVATIONS ON APRIL 28, 1911.

The following day, Thursday (April 27), was more or less cloudy and showers fell repeatedly, considerably hampering and retarding our preparations for the morrow's work. I had to turn the photographic work over to selected officers of the *Annapolis*, supplying them with Abbot's directions[1] and establishing for them the azimuth and altitude of the Sun at the time of the total eclipse the following day so as to guide them in setting up the photographic apparatus. I was, furthermore, obliged to train an inexperienced man in taking readings of the magnetic declination. By thus dividing up our labors, it was possible to carry out the program in a general manner, at least, if not with the elaborateness and detail of an especially equipped eclipse party.

The Samoan inhabitants of the island did everything possible for our comfort and were eager to render every assistance. At 4 p.m. they served their native drink—the kawa—and in the evening at 7 o'clock the Samoan chiefs gave us a native feast, followed by a native dance—the siwa—arranged for by Queen Vaitupu, our hostess. I was obliged to leave before the dance was over in order to complete the computations and preparations required for the next day's work. Retiring about 1 a. m., I arose at 6 o'clock and found that the weather on the eventful day, April 28, was apparently all that could be desired.

Final preparations were immediately made for the eclipse observations, the photographic work being placed in charge of Lieutenant McDowell, aided by Dr. Connor and Messrs. Steffany and Reed, and the times of contacts were to be observed by two independent parties, one aboard the *Annapolis* in Faleasau Bay, in charge of Lieutenant Baker, and the other ashore by Dr. Connor, aided by Chaplain Pierce. The magnetic declination readings were intrusted to Quartermaster Urle and the general charge of the entire work was reserved for myself, as also the necessary astronomical observations for approximate geographic

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[1]These were as follows:

"On the night before the eclipse fill the plate-holders. Put two Seeds ortho non-halation dry plates in one, two Seeds 27 dry plates in the other. This must be done in complete darkness. The *film side of each plate must be outside.* In other words, the two glass sides of the two plates in a plate-holder must be back to back (*i. e.*, nearer together than the two film sides). To make sure of this in the dark, *wet the end of the finger* and try it at the edge of each plate. The sticky side is the film side. Keep the plate-holders wrapped in dark cloth, and as cool as can be, until nearly time (within 15 minutes of time) for totality. Then insert the plate-holders at the lower end of the tin tubes. Wrap the cloth around the end till within two or three minutes of totality; then it can be removed, if desirable.

"Make a shutter to cover the lenses with; a pasteboard box about 8 inches or 10 inches wide, 16 inches or more long, and of any convenient depth, will suffice. Fasten to it a bamboo or other light pole about 8 feet long. Before totality, put this box over the lenses, tying the pole with a string to the tubes at the bottom, or better, making a little wire hook projecting from one of the tin tubes to hold the lower end of the pole. Have an assistant handle this box during totality, holding it in place in his hand ready for any movements desired.

"When totality has come, draw the *upper* slide from each plate-holder. Lift off the box-cover from the lenses. Expose 15 seconds, following the Sun during the exposure by unscrewing the right-ascension screw slowly. Then put on the box-cover. Push in the slides. Draw out both plate-holders, turn them over and reinsert them. Draw the new upper slides. Lift off the box-cover. Expose until the totality is within 30 seconds of ending. Follow the Sun as before. Put on the box-cover. Push in both slides. Turn the brass hooks to prevent either slide from being withdrawn by accident. Remove the plate-holders and wrap them in dark cloth. Keep them cool as possible till developed.

"It will be well to have two assistants: one to call out the minutes elapsed and tell you when to cover first and second times, the other to cover and uncover the lenses as directed."

position, azimuth, and time, all of which had to be done on the morning of the day of the eclipse. Unfortunately, owing to the bad weather of the day before, it had not been possible to place the photographic apparatus in final position so as to try out the finding telescope, attached to the camera, until a few minutes before the eclipse. Lieutenant McDowell then learned to his chagrin that the finder did not work satisfactorily, and hence was obliged to get up some simple device with the aid of which he might keep the Sun's disk as central as possible on the photographic plates and eliminate the diurnal motion. For orientation of the camera-tubes in azimuth and altitude, it was necessary to resort to the preliminary lines which I had established the day before with the aid of an approximate value of the magnetic declination and my calculated azimuths and altitudes of the Sun for the totality phases. For a general view of the eclipse station at Tau, see Plate 10, Fig. 1.

I was prevented from rendering further assistance to the photographic party, as I was obliged at the critical moment to be inside the magnetic observing-tent, the recorder having sent an urgent call owing to trouble with the lamp which lighted up the magnet-scale. However, Abbot's program calling for a 15-second exposure (one with each plate), and the other as long as possible, about a minute, again with each plate, was carried out by Lieutenant McDowell and his assistants as carefully as possible. Four photographs of the eclipse were thus secured, two exposures of 15 seconds and two of 70 seconds; upon development of the plates at Apia, it was found that one of the plates was originally defective, being full of pin holes, and another was light-struck. The better one of the short-exposure plates is reproduced in Fig. 3, Plate 10.

It will be seen that the improvised sighting-device had not been wholly successful, and the photographs, accordingly, exhibit slight defects due to diurnal motion. Apart, however, from these defects, the photographs show clearly not only the inner corona but also most interesting details and coronal extensions reaching out more than one-half of the Sun's diameter. The form of the present corona is in conformity with that observed by others near a Sun-spot minimum.

I had just completed my azimuth observations when, looking through the telescope, it was found that the eclipse had already begun, viz, at about $8^h 52^m$ a. m. local mean time. However, the two parties who had been intrusted with observing the times of contact obtained all four. Totality began about $10^h 07^m$ and lasted, according to the ship party, $2^m 03^s$, and according to the shore party, $1^m 59^s.5$, which is as satisfactory an agreement as could be expected with the limited observing means—sextant telescope aboard ship and a powerful field-glass ashore. The final contact occurred about $11^h 32^m$ a. m. The approximate position of our station, according to my solar observations with the theodolite of magnetometer No. 14, was 14° 14′ S. and 169° 33′ W. of Greenwich.

Words will inadequately describe the mingled feelings one has when the supreme moment arrives for which more or less extensive preparations have been made. We were in a most beautiful tropical country, surrounded by luxuriant cocoanut and banana groves; from our station it was not possible to command an extensive view, and so we could not experience the sensations others have had with the swiftly approaching shadow. Neither I, nor any one whom I saw, many natives being close by, showed any signs of depression. The natives, to be sure, had been thoroughly instructed the day before regarding the great event. There was a feeling almost of exhilaration, even during absolute totality.

The rough notes made at the time read as follows: Corona not pronounced, appeared like a mere ragged fringe of soft, pearly light; slight indication of streamers, which appeared somewhat longer near the poles. Small filaments almost completely around the disk. No absolute darkness; could readily read my writing. Weather very fine throughout the day; not showery at any time—an experience unusual for this tropical region, especially at this time of the year.

Later, after the development of the photographs, the following note was added: Observed the eclipse through the telescope of the theodolite accompanying magnetometer

No. 14, as also through blue glasses, and at no time saw the equatorial extensions shown in the photographs, nor were any protuberances, glowing hydrogen flames, seen at any time, as also no stars near the Sun's disk. To me it seemed as though the sky was absolutely clear, no clouds being visible, though there might have been a fine haze sufficient to obscure the faint light from the coronal extensions.

Lieutenant McDowell reported to me later (August 21, 1911) as follows: "I have asked all members of our party in Tau and have found no one who saw stars or extension of flame as shown by sketch.[1] Just before the Sun was eclipsed I remarked to Doctor Connor that it was getting cloudy and I doubted whether we would get a picture, but as we still saw the Sun apparently very plainly I thought the haze was due to the strange light of the eclipse. I now believe that there was a slight haze at least over the Sun. One of the observers on the *Annapolis* says he saw two stars, one near the Sun and one a little distance from it; he had not seen the sketch and I do not believe knew of other people seeing stars. He did not remember seeing any extensions. On the 15-second exposure I did not touch the motion-screws at all, the frame that the camera was mounted on was so frail that the least touch would move the camera and probably the superposed pictures were caused by a slight motion of the camera when Reed shoved in the slides or by the camera being blown by the wind."

Hence the great coronal extensions, which were chiefly in the Sun's southwestern and northeastern edges, were not seen visually by any member of the shore party nor by the party aboard the *Annapolis*, anchored a few miles distant, in Faleasau Bay. However, as noted below, they were seen at sea by Captain Holford on board the *Tofua*, and by Mrs. Clement Wragge, who, with her husband, the well-known meteorologist, was located near Hapaii Island.

It is greatly to be regretted that the better equipped and specially trained astronomical parties at Vavau, Tonga, were not blessed with the singular good fortune which befell us at Manua Island. For our prime work—magnetic—it would not have mattered had the weather been bad.

Plate 10, Figs. 4 and 5, shows side by side Professor Langley's sketch of the eclipse of 1878, and that by Captain Holford of the eclipse of April 28, 1911. The juxtaposition of the two sketches exhibits a remarkable similarity between them. The interval between the two eclipses was 33 years, or about three times the Sun-spot cycle. The two years were furthermore years of minimum Sun-spot activity, or close to it. We thus see how the equatorial extensions have repeated themselves for these two years.

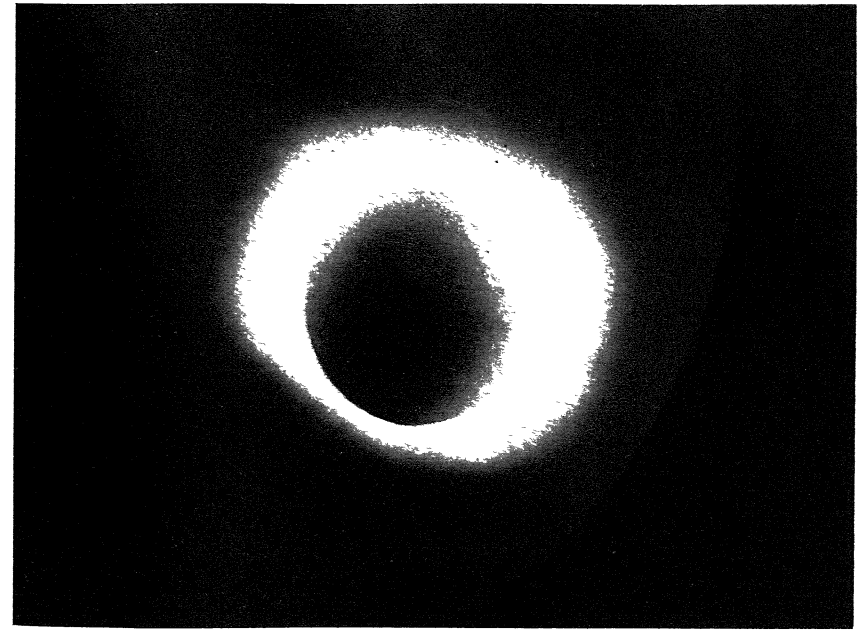
The accumulated observations have now definitely proved that the solar corona passes through a cycle of changes in entire rhythm with the Sun's activity as displayed by Sun-spots and solar eruptions. Furthermore, as has been pointed out by various investigators, the coronal streamers may map out the lines of force of a possible magnetic field enveloping the Sun, in much the same manner as the polar-light streamers visualize the lines of magnetic force extending from the Earth. Hence, the study of the solar corona and its transformations has become of as great interest to the magnetist as to the astrophysicist.

The *Annapolis* being required, as already stated, for Governor Crose's official trip to Apia, it was necessary to leave Manua Island as soon as possible after the eclipse. We, accordingly, left the island on the day of the eclipse, about 3 p.m., arriving at Pago Pago the following morning, where until my departure I was once more Governor Crose's guest at his official residence.

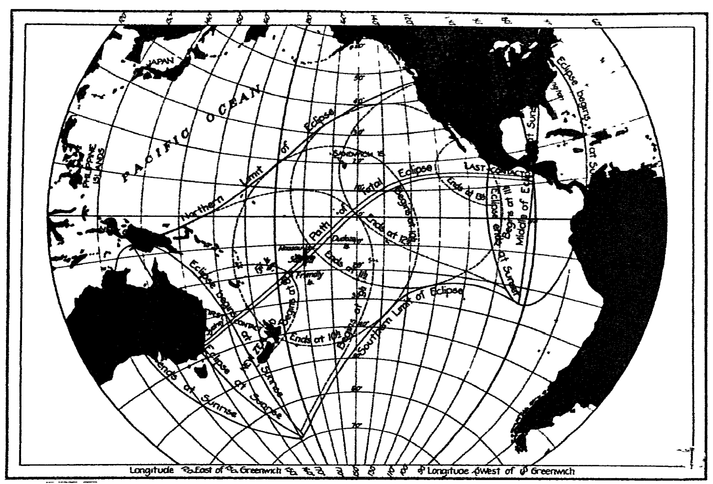
On May 2, I determined the magnetic elements at a station on the parade grounds at Pago Pago. Leaving the same evening aboard the *Annapolis*, Apia was reached the following morning, May 3. The eclipse plates were immediately turned over to Mr. Tattersal,

[1] I had sent Lieutenant McDowell a copy of Captain Holford's sketch of the corona as seen at sea off the Tonga Islands.

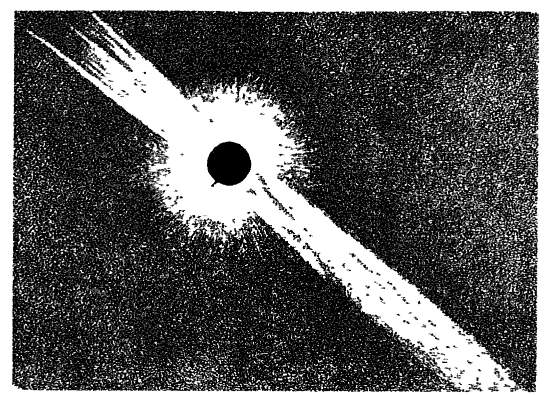
1



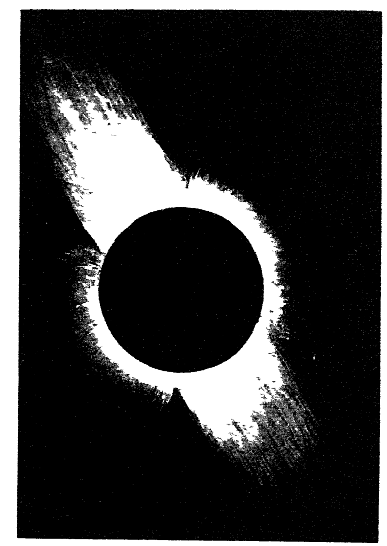
3



2



4



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Eclipse Expedition to Manua, Samoan Islands, April 28, 1911.

1. General view of eclipse station at Tau, Manua Island.

2. Path of totality for solar eclipse, April 28, 1911.

3. The solar corona as photographed at Tau, Manua Island, April 28, 1911

4. Professor Langley's sketch of the solar corona, 1878

5 Captain Holford's sketch of the solar corona, April 28, 1911.

a photographer, for development and taking prints. On the 4th the steamer *Tofua* arrived from the Tongas, having aboard the various eclipse parties, among others the Australian astronomers, who reported having had more or less unfavorable conditions during the eclipse. As far as could be ascertained, my own party at Manua Island had been favored with the best weather.

I left Apia, May 8, on the steamer *Atua*, bound for Auckland. On the 10th we arrived at Vavau, of the Tongas, the scene of great activity just a few days previous, owing to the advent of the many astronomers who had selected this station as the most favorable and most accessible point. The next morning (May 11) we arrived at Hapaii, where we took aboard Mr. and Mrs. Clement Wragge, who had observed the eclipse in this vicinity. They reported having had more favorable conditions than had been experienced by the English and the Australian parties at Vavau. Mrs. Wragge had made a drawing of the corona which agreed well with a similar sketch made by Captain Holford, of the *Tofua*, which I had seen at Apia.

I must not fail at this point to express my obligation to Commander (now Captain) Crose, U. S. N., at the time Governor of Tutuila, Samoa, for the very substantial aid rendered in promptly putting at my disposal the *Annapolis* and her personnel. Not only was I conveyed on the *Annapolis*, with my entire instrumental outfit, to the observation station on Manua Island, but there was also put at my disposal services without which the desired end could not have been attained. Particular mention should be made of the zealous and effective cooperation received from Commanding Officer Lieutenant McDowell, Executive Officer Lieutenant Baker, Captain Steffany of the *Altair*, Mr. Reed, as assistant photographer, and Quartermaster Urle, as magnetic recorder. Chaplain Pierce and Doctor Connor also assisted in various ways.

It is likewise a pleasant duty to speak of the cordial assistance rendered by the Samoans of Manua; reference has already been made to the whole-hearted hospitality and uniform courtesy shown by them, especially by Queen Vaitupu, in whose house the party had the privilege of living, and by the various chiefs, who arranged for our entertainment. The remembrance of the happy days spent amidst these very friendly people will be a never-ending source of pleasure.

So, likewise, the numerous courtesies shown me at Apia by the German Governor, Dr. Erich Schultz, and his various officials, as also by Dr. Hammer, of the Geophysical Observatory, and by the American consul, Mr. Mason Mitchell, deserve grateful acknowledgment. And last, but not least, must be mentioned the effective aid rendered by Mr. Abbot in supplying the apparatus and the requisite instructions for the photographic work.

MAGNETIC OBSERVATIONS ON APRIL 28, 1911.

According to special arrangement, magnetic observations simultaneous with ours at Tau were made at the five magnetic observatories of the United States Coast and Geodetic Survey, also at Melbourne, Christchurch, and Apia, where quick-run magnetograms were obtained for five hours. Until the records have been received from stations over the entire globe, it will not be possible to determine definitely whether or not the present eclipse was accompanied by any minute and temporary change in the Earth's magnetism. It is proposed to devote a future monograph to this special subject and there bring together all the magnetic results obtained during recent eclipses.

MAGNETIC INSPECTION TRIP.

Having completed some magnetic observations at the Geophysical Observatory, I left Apia, May 8, visiting *en route* to Colombo the magnetic observatories at Christchurch, New Zealand, and Melbourne, Australia. At Melbourne I also concluded arrangements for cooperative magnetic work in Australasia and with the Australasian Antarctic Expedition.

Arriving at Colombo, Ceylon, on June 21, I found the *Carnegie* awaiting me. Sailing with her on July 6, Port Louis, Mauritius, was reached on August 1, a successful series of magnetic observations having been secured on the entire trip. While aboard I inspected the ocean work, carried out some additional experiments, and gave the requisite supplementary instructions to Mr. W. J. Peters, in command of the vessel. The route to Mauritius was also arranged so as to secure intersections with the tracks of the German Antarctic ship of 1902–1903, the *Gauss*.

At Port Louis, the Royal Alfred Observatory at Pamplemousses was visited and a cooperative arrangement entered into with the Governor of Mauritius whereby the observatory magnetic work could continue to be made promptly available to the Department of Terrestrial Magnetism in return for a new vertical-intensity variometer and earth inductor supplied by the Department. In this connection I also made a partial investigation of the pronounced local magnetic disturbances existing on the island of Mauritius and beyond, as disclosed by our sea observations.[1]

The *Carnegie* was ready to sail again on August 16, and on the return trip to Colombo the route was extended sufficiently into the Bay of Bengal to fix the position of the agonic line. A report was prepared on the large errors found in the existing magnetic charts of the Indian Ocean, and the large secular changes in this region were pointed out.[2]

Arriving at Colombo on September 10, I gave final instructions to Mr. Peters respecting the ocean magnetic work, and then left on the 11th for Bombay, visiting *en route* (September 12–13) the magnetic observatory at Kodaikanal, Southern India, as also (September 16) the old magnetic observatory at Madras. Bombay was reached on the 18th, and in the afternoon a visit was paid the Government Meteorological and Magnetic Observatory at Colabá, in charge of Professor N. A. F. Moos. September 19 to 21, I visited, in company with Professor Moos, his well-equipped new observatory at Alibag, and made there a few comparison observations, using my magnetometer No. 14; the results of these observations will be found given on pages 219–221 of this volume. We returned to Bombay Thursday afternoon, the 21st, and on the following two days I conferred with Professor Moos at Bombay regarding various matters. Leaving on the afternoon of September 23, I arrived on the morning of the 27th at Dehra Dun, in Northern India, the chief station of the Magnetic Survey of India, and proceeded the next day to the summer office of the Survey on the mountain at Mussoorie. Here I conferred regarding magnetic matters with Colonel Burrard, who had just been appointed Surveyor General of India, and with Captain Thomas, then in charge of the magnetic-survey party. I returned to Dehra Dun on the following day, September 30, made two sets of magnetic observations at the Dehra Dun Magnetic Observatory, leaving 9 p. m. for Calcutta, which I reached on October 3. Considerable difficulty, on account of excessive moisture, is encountered at the underground magnetic observatories, Kodaikanal and Dehra Dun.

On October 4 the Barrakpore Magnetic Observatory, near Calcutta, was visited, and on the 5th the Alipore Meteorological Observatory. I left Calcutta on the 6th for Batavia, via Rangoon and Singapore, visiting *en route* (October 10–11) the Magnetic Observatory at Toungoo, Burma. At Singapore, October 17, I inspected the various sites where magnetic observations had been made previously, and finally arrived at Batavia on October 22.

October 23 the Batavia Magnetic and Meteorological Observatory was visited and on the next day I proceeded with Dr. van Bemmelen, the director, to the new magnetic observatory at Buitenzorg. Having given Mr. Peters the requisite directions regarding the shore work and comparisons at the Batavia Observatory, I was able to leave Batavia on the 29th, and arrived at Hongkong on November 7. After visiting the Observatory here, I departed in the afternoon for Canton, where, in the absence of Dr. Edmunds, a conference

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[1]The preliminary report on this subject was published in *Terr. Mag*, vol. 16, 1911, p 243.
[2]Published in *Terr. Mag*, vol. 16, 1911, p. 133.

was held the following day with Professor Fuson regarding magnetic work in China. The Portuguese station at Macao and the various sites for magnetic work there were examined on November 9. November 13 to 15, I visited at Manila the sub-office of the Coast and Geodetic Survey, the Manila Meteorological Observatory (Reverend Jose Algué, director); also, in company with Reverend Saderra Maso, I went to the new magnetic observatory at Antipolo.

On concluding the necessary arrangements at Manila respecting the *Carnegie's* visit to this port, I had accomplished the main purposes of my inspection trip. However, on my return journey to Washington, I also visited the following observatories: Zikawei (November 20), Tsingtau (November 22), Tokio (November 27), Honolulu (December 7), Mount Wilson (December 15–16), Tucson, Arizona (December 18). I arrived in Washington on December 24, having been absent 9 months, the total distance traveled approximating 47,000 miles. Besides the eclipse work and the inspection trip on the *Carnegie*, 18 magnetic observatories were visited, and some comparisons were secured at 3 of them; various other representative scientific institutions interested in terrestrial magnetism, atmospheric electricity, and allied topics were also paid visits. I wish to express here my grateful appreciation of the courtesies everywhere received and the special efforts made by those in charge to familiarize me with the work of their respective institutions.

It had been my original intention to return to Washington via Siberia, and to visit magnetic institutions *en route* from Tokio, but circumstances made necessary an alteration of plans. However, during a two months' trip to Europe in the spring of 1913, I was enabled to visit, besides other institutions, the following additional magnetic observatories: Potsdam and Seddin (May 6), Rude Skov, near Copenhagen (May 16), and Greenwich (May 29).

I now have, by personal visits, made myself acquainted with 28 of the existing magnetic observatories, and 6 of the remaining number, about 17, have been visited by other representatives of the Department. In this way the Department of Terrestrial Magnetism has been enabled to come into pleasant relations and enter into effective cooperation with the existing magnetic services the world over.

RESULTS OF COMPARISONS OF MAGNETIC STANDARDS, 1905-1914.

By L. A. Bauer and J. A. Fleming.

EXPLANATORY REMARKS.

This part of the present volume contains, first, the results of the various intercomparisons of magnetic standards obtained by the observers of the Department of Terrestrial Magnetism, from 1905 to 1914, inclusive, the world over, both at magnetic observatories and in the field among themselves. Secondly, there will be found a preliminary summary of the results of intercomparisons in recent years by others, and an exhibit of the relation of these results to those of the Department. Preliminary results of some of the comparisons have been published in *Terrestrial Magnetism and Atmospheric Electricity*, vol. 14, pp. 3–16, 1909; vol. 16, pp. 61–84, and pp. 137–162, 1911; and in Land Magnetic Observations, 1905–1910, p. 43. A provisional summary, up to 1910, was prepared for the meeting of the Magnetic Commission of the International Meteorological Conference held at Berlin in September 1910, and printed in the Report of the Proceedings. *All previous results are superseded by those in the present report.*

When a general magnetic survey of the globe is to be executed on a common and consistent plan, it becomes a matter of importance to know how far instrumental constants and reductions to standards, as determined at one place, can be relied upon in other places where the magnetic elements are considerably different, or what changes may be expected during strenuous field campaigns, such as must be carried out in more or less unexplored countries. If, furthermore, the magnetic results obtained by various organizations, using instruments of greatly different construction, are all to be reduced to a common basis, it becomes increasingly important to have the requisite data at hand for the proper correlation of all work.

It has been found that, for one reason or another, magnetic instruments may differ among themselves by quantities far exceeding their observational errors. Sometimes these differences can be referred to defective constants, at other times they are due to causes inherent in the instruments themselves. Thus, for example, referred to a standard which, according to elaborate tests, appears to give values of the horizontal intensity, H, of an absolute accuracy on the order of 1 in 10,000, the H-corrections, as will be seen later, for 17 magnetic observatories over the Earth are within $0.0005H$, some being plus and some minus. For 15, the correction reaches $0.0005H$ to $0.001H$, and even more—quantities approaching or even exceeding the errors of good field-instruments.

Whenever circumstances permitted, the *method of intercomparisons* of magnetic instruments described in Vol. I, pp. 19–20, was followed. Only occasionally did it happen that, for lack of time or other reason, the full program had to be curtailed.

Disturbed sites are avoided for the intercomparisons of instruments, but this can not always be done in the field, as for example, in the ocean work where islands, or ports, often afford the only opportunity for the desired comparisons. If the preliminary examination has shown the existence of pronounced local magnetic disturbance, and if another site is not available, it is arranged that, at the same station, the magnetic systems of the various instruments are in the same horizontal plane. Should this procedure not be possible, then the height of magnet from a suitable reference point, *e. g.*, from the top of a stake driven into the ground, is carefully noted and determinations are made at each station to find the necessary corrections for the various levels in which the intercomparisons had to be secured. With these precautions, it has been found that results of sufficient accuracy for field work can be obtained.

Generally but two stations are required, which, unless already named, as may be the case at observatories, are designated A, B. For observatory work B is the auxiliary station and A the regular observing pier; at some observatories different piers or stations are used for the various elements and intercomparisons for each particular element must be made accordingly. The azimuth lines for both stations are preferably referred to the same determination of azimuth, especially when no exchange of stations can be effected. Whenever possible both stations are placed in the same azimuth line and the same mark is used at each, thus assisting in the avoidance of extraneous error. Triangulation between stations for azimuths of marks is resorted to only when absolutely necessary.

To secure reliable results expeditiously, simultaneous observations with the instruments being compared are preferred, as also an exchange of stations; in this way any possible station-difference may be at once eliminated and the desired instrument-difference be derived without recourse to auxiliary instruments, e. g., magnetographs. At observatories where the same piers used in determining the magnetograph base-lines may be utilized and the required magnetogram-data be obtained promptly, there may be no necessity for an exchange of stations and simultaneity of observations, though this is found, in general, to be the better procedure. When tripods must be used, each instrument is mounted each time on its own tripod.

When, for some reason, simultaneous observations are not possible, the observations are carried out alternately at each station by the same observer with the two instruments 1 and 2, and the stations A and B as follows: observations with 1 at A, with 2 at B; 2 at B, 1 at A; 1 at A, 2 at B; 2 at B, 1 at A; and so on; next, 2 at A, 1 at B; 1 at B, 2 at A; 2 at A, 1 at B; 1 at B, 2 at A; and so on. As little time as possible is allowed between determinations at the two stations in order to minimize outstanding effects of corrections to common epoch. With the number of determinations called for, this scheme of observation, while of course not as good as simultaneous intercomparisons, nevertheless yields good results when used with care.

Whenever possible, the practice is to secure with each instrument at least 12 complete determinations of declination, 6 at each station; 6 complete determinations of horizontal intensity, 3 at each station (one determination consisting of two sets of oscillations and two sets of deflections at two or more distances); and at least 6 determinations of dip with each needle, 3 at each station. The observations are made for different orientations of the foot-screws of the instruments, preferably so that there will be an equal number of observations at each station for footscrew marked A south, footscrew B south, and footscrew C south. The work for any one element is not completed on one day, but distributed over several days in order to minimize a possible effect due to magnetic perturbations. Where an exchange of stations is not practicable, the total number of determinations for each element is at least as great as just stated. Particular care is used to see that the instruments are in good working order and the requisite caution is exercised to insure the absence of disturbing influences of whatever character. Before leaving the station, the computations are completed far enough to make sure, at least, that no observational blunders have been made.

Of special interest will be found the tables exhibiting the results of comparisons secured at the same observatory at different times, *e. g.*, before and after strenuous field work, or by different observers of the Department with different instruments. These repetitions will serve as some guide in answering the questions raised above, and in showing how closely the Department of Terrestrial Magnetism, with its instruments and its methods, can reproduce its standards in remote parts of the Earth.

It is a pleasure to record our indebtedness to the directors of the various observatories, and to the members of their staffs, for the very cordial assistance rendered, as well as our appreciation of the uniform courtesies extended to the representatives of the Department.

The *instruments* used by the Department observers are designated by their respective numbers, which will serve at the same time, by referring to Vol. I (pp. 2–11) and the

present volume (pp. 5–15), to identify and to describe them. The magnetometers are almost invariably of the design of the Department, in most cases constructed directly in its own instrument shop, or according to its own specifications. The dip circles, with the exception of No. 18 by Casella, are all of Dover make, with certain modifications in some cases as specified by the Department. The earth inductors Nos. 2 and 48 are of the Wild-Eschenhagen type, the first constructed by Toepfer, of Potsdam, and the latter by Schulze, also of Potsdam. The Department is now constructing its own earth inductors.[1]

The *corrections* applied to the magnetometers and dip instruments in order to refer the results obtained to the provisionally adopted standards of the Department are as enumerated in Vols. I (pp. 44–50) and II (pp. 16–20).

The *provisional standards* of the Department of Terrestrial Magnetism for the comparison results obtained up to the end of 1914 were the same as for the results of the field work during the period 1905–1913, namely: For declination, C. I. W. magnetometer No. 3 without correction; for horizontal intensity, C. I. W. magnetometer No. 3 with a correction of $+0.00015H$ applied to observed values of H, the horizontal intensity; for inclination, earth inductor No. 48 with a correction of $-0.'5$ applied to observed values of inclination. The possible errors of the provisional standards are discussed later (pp. 271–273).

The tables of comparison-results for the various magnetic observatories, or services, will be found given in alphabetical order. No special explanation is required, except that C. I. W., standing for "Carnegie Institution of Washington," means the result obtained by the observer of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and reduced to the provisional standards as just specified. The reductions to "International Magnetic Standards" (I. M. S.) are made in accordance with the statement on page 273. Additional details regarding the comparisons will be found in the final summaries (p. 278).

Throughout the tables, declination, D, east, and inclination, I, north end of needle below horizon, are designated by the plus sign. The difference, C. I. W. – Observatory, is taken algebraically. Horizontal intensity, H, is of course to be regarded as plus, whether the value applies to the northern or to the southern magnetic hemisphere. For convenience in expressing the H-differences, the values of H are given in gammas (γ), *i. e.*, in units of the fifth decimal C. G. S. The mean H-difference is, furthermore, expressed in parts of the observed H for the purpose of facilitating its application to places of different H. It is not correct, as may have been first pointed out by one of the writers,[2] to assume that the intensity correction of a magnetometer, expressed in absolute units, will remain the same with change of magnetic field, the amount of the correction depending, in fact, upon the absolute value of the intensity at the place of observation. From whatever source the correction generally arises, it can be expressed, with close approximation, by a simple ratio change, *i. e.*, a factor multiplied into the first power of the value of the intensity; only in certain extreme cases will a second term, involving the second power of the intensity, enter appreciably.

NO. 1.—AGINCOURT OBSERVATORY, NEAR TORONTO, CANADA.

Three stations were used in the 1906 comparisons at the Agincourt Observatory: for declination a tent station, T, was chosen as close as possible to the declination pier, which could not be occupied without dismounting the Observatory instrument; for horizontal intensity both T and the regular intensity pier, I, were used; for the dip work, T, I, and the regular dip pier, D, were occupied.

The standard instruments of the Observatory were for September and October 1906: Toronto declinometer for declination; Elliott magnetometer No. 48 for horizontal intensity;

[1]See "Description of the C. I. W. Combined Magnetometer and Earth Inductor," by J. A. Fleming and J. A. Widmer, *Terr. Mag.*, vol. 18, 1913, pp. 105–110, also this volume, pp. 9–12.

[2]L. A. Bauer, *Terr. Mag.*, vol. 12, 1907, p. 161, footnote.

and Dover dip circle No. 130, with needles 1 and 2, for dip. In November 1906, Elliott magnetometer No. 98 was substituted for Elliott No. 48; dip circle Dover No. 130 was also later superseded by Dover No. 200 with needles 1 and 2. Accordingly, only the mean results of the 1906 comparisons are given.[1] The instruments used by Observer P. H. Dike for the C. I. W. observations were: Coast and Geodetic Survey magnetometer No. 20 and Dover dip circle No. 172 with needles 1 and 2. Series A and B were obtained, respectively, before and after Mr. Dike's field work in Canada.

Station T was placed 5.5 feet south of the Observatory building, and in line with the declinometer pier and the azimuth mark about 4 miles distant. The same mark and the same azimuth could therefore be used at both T and the declinometer pier but, for the reason mentioned above, the stations could not be exchanged; accordingly, any possible difference in declination between the two stations is included in the quantity C. I. W. − Agincourt (Toronto declinometer), given in Table 1 A.

The observatory data for D and H were derived from the magnetograms; however, two of the D-values were obtained from eye-readings with the declinometer, made simultaneously with the D-observations by Mr. Dike. The H-observations by Mr. Dike were made partly at station I and partly at station T. The results of the inclination comparisons were obtained from simultaneous observations with the two dip circles compared, the stations used being I, T, and D.

The corrections applied to Mr. Dike's values to refer them to the adopted C. I. W. standards were: $+0'.5$ (for declination), $+0.00110H$ (for horizontal intensity), and $-0'.8$ (for inclination). These corrections resulted from comparisons at Washington and at the Cheltenham Observatory before and after the Agincourt comparisons. No appreciable difference was found in inclination between stations I, T, and D; for horizontal intensity the small station-difference of $I-T=+1.0\gamma$ resulted from the observations, and was applied to the observed values.

TABLE 1 A.—*Results of Comparisons at the Agincourt Observatory in 1906.*

Series	Date	C. I. W.—Agincourt (declinometer)		C. I. W.—Agincourt (Elliott 48)		C. I. W.—Agincourt (Dover 130)	
		Declination	Sets	Horizontal intensity	Sets	Inclination	Sets
	1906						
A	Sept. 6 to 10	$+0'.2$	6	$-6.3\gamma=-0.00038H$	6	$+0'.6$	6
B	Oct. 8 to 11	0 .0	5	$-6.8\gamma=-0.00042H$	6	$+1.0$	6
I = A & B	Adopted	$+0.1$	11	$-6.6\gamma=-0.00041H$	12	$+0.8$	12

From November 1906 to April 1908, horizontal-intensity comparisons were made at the Agincourt Observatory between the two Elliott magnetometers, Nos. 48 and 98. The following difference, as communicated by Director R. F. Stupart on January 10, 1911, was found:

II. Agincourt (Elliott 98 uncorrected) − Agincourt (Elliott 48) = $+10\gamma = +0.00061H$.

Accordingly, from I and II, we have:

III. C. I. W. − Agincourt (Elliott 98 uncorrected) = $-16.6\gamma = -0.00102H$.

In 1909 comparisons were made at Agincourt by the Meteorological Service of Canada between magnetometers Elliott No. 98 and C. I. W. No. 8, loaned the Service for use during the expedition in 1908–1909 of the steamer *Arctic;* No. 98 was mounted on Observatory pier C, and No. 8 on pier B. This series, IV, was obtained soon after the return of the expedition. C.I.W. No. 8 was standardized at Washington before and after this expedition and the following corrections on the C.I.W. standards were found: for declination, $+0'.8$, and for horizontal

[1]The observations are published in full in *Terr. Mag.*, vol. 16, 1911, pp 79–81.

intensity, $+0.00006H$; the tabulated values are the observed ones by W. E. W. Jackson, with these corrections applied. Stations were not exchanged.

In 1910 a fifth series (No. V) of comparisons was made by the Agincourt Observatory between magnetometers Elliott No. 98 and C. I. W. No. 15, constructed and standardized for the Meteorological Service of Canada by the Department of Terrestrial Magnetism. The corrections of No. 15 on the C. I. W. standards, as resulting from the observations at Washington in February and March 1910 were: for declination, $+0'.1$, and for horizontal intensity, $+0.00035H$; the tabulated quantities are the observed values by W. E. W. Jackson, with these corrections applied. No. 98 was mounted on Observatory Pier C, and No. 15 on Pier B; stations were not exchanged.

TABLE 1B.—*Results of Comparisons by the Meteorological Service of Canada at the Agincourt Observatory, 1909–1910.*

Series	Date	Mean 75th meridian time	Declination obtained		C I.W. —Agincourt (declinometer)	Date	Mean 75th meridian time	Horizontal intensity obtained		C I.W.—Agincourt (Ell 98)
			C. I. W.	Agincourt (declinometer)				C I W	Agincourt (Ell 98)	
	1909	h m	° ′	° ′	′	1909	h m	γ	γ	γ
IV	Oct. 29	12 51	−6 08 9	−6 06 0	−2 9	Oct. 29	14 10	16294	16293	+1
	29	15 13	07.0	6 06 0	−1.0	Nov. 2	11 29	248	268	−20
	Nov. 2	10 29	00 4	5 58 0	−2 4	2	14 36	270	298	−28
	2	12 21	05 0	6 04 0	−1 0					
	2	13 49	07 8	05 9	−1 9					
	2	15 23	05 9	04 5	−1 4					
	3	15 11	06 2	04 5	−1 7					
	3	15 21	06 0	04 3	−1.7					
				Mean	−1.7				Mean	−15 7
	1910					1910				
V	Apr. 21	13 06	−6 08 1	−6 08 1	0 0	Apr. 21	13 54	16268	16282	−14
	21	15 12	07 5	07 3	−0 2	Sept 28	16 01	252	268	−16
	Sept. 28	15 11	07.6	05 5	−2 1	29	11 50	184	197	−13
	28	16 45	04 7	04 2	−0 5	Oct. 19	11 42	202	213	−11
	29	10 36	18.4	17 8	−0 6	19	14 14	218	231	−13
	29	12 26	19.9	19.0	−0 9					
	Oct. 18	16 01	08 1	06 8	−1 3					
	19	10 48	10 3	09 0	−1 3					
	19	12 22	16 0	14 0	−2 0					
	19	13 32	14 0	13 2	−0 8					
	19	14 48	20 0	19 3	−0 7					
	19	15 20	18 7	17 8	−0 9					
	19	15 39	14 1	13.4	−0.7					
				Mean	−0 9				Mean	−13 4

Summarizing the results obtained up to the end of 1910:

TABLE 1C—*C. I. W—Agincourt (Declinometer; Elliott No. 98 uncorrected).*

Series	Declination	Horizontal intensity	Remarks
	′	γ	
I (1906)	+0 1 (weight 1)		Stations for series I not the same as for III, IV, and V, possible station-differences not eliminated
III (1906–08)		−16 6 (weight 2)	
IV (1909)	−1 7 (weight 2)	−15 7 (weight 1)	
V (1910)	−0 9 (weight 3)	−13 4 (weight 2)	
Weighted mean	−1 0 (?)	−15 1γ or −0 00093H	

The results in Table 1C show a very satisfactory agreement as far as the horizontal intensity is concerned, especially when it is remembered that different standardizing magnetometers were employed in each case. The results in declination are not so good,

however; for this element the standardizing instruments could not be mounted on the observatory pier for declination, it being impracticable, as already explained, to dismount the Observatory declinometer; accordingly, the discordance in the results may arise, in part, from causes other than purely instrumental ones.

In February 1911 a new determination of the instrumental constants of Elliott No. 98 was made by the Agincourt Observatory, as the result of which, according to Director Stupart's letter of March 17, 1911, it was found that the H values computed with the old constants required a correction of $-0.00116H$. The old constants had been determined at Kew. *Hence we have finally, up to 1911:*

VI. *C. I. W. — Agincourt (Elliott No. 98 corrected)* = $+0.00023H$.

Of dip comparisons later than those of 1906, there is but one series available, namely, comparisons made by the Agincourt Observatory in 1910 between the Agincourt dip circle (Dover No. 200, needles 1 and 2) and C. I. W. dip circle (Dover No. 205, needles 1 and 2), standardized at Washington in April 1910 and again in March 1913, the mean correction being $-0'.4$; this correction has been applied to the observed values with No. 205. No. 200 was mounted on Observatory pier D, and No. 205, on pier E; the observations were simultaneous, but stations were not exchanged.

TABLE 1 D — *Results of Inclination Comparisons at the Agincourt Observatory, 1910*

Series	Date	Mean 75th meridian time	Inclination obtained		C.I W. — Ag (200)
			C. I. W.	Ag. (200)	
	1910	h m	° ′	° ′	′
VII	Sept. 28	12 16	+74 40 4	+74 39 6	+0 8
	29	14 18	40.9	40 8	+0 1
	Oct. 18	14 58	38 2	37 8	+0 4
	18	12 10	40 0	39 5	+0 5
	Mean value of (C.I.W. — Agincourt D.C 200)				+0 4

Comparisons between Dover No. 200 and Dover No. 130 were made by the Agincourt Observatory, Nov. 1911 and Feb. 1912, No. 200 being on pier D, and No. 130 on pier E. The mean result of 5 sets of simultaneous observations, without exchange of stations, was:

VIII. Dover No. 200 — Dover No. 130 = $-0'.9$.

Furthermore, in 1912, Dover No. 200 was compared with the new inclination standard of the Agincourt Observatory, namely, Toepfer earth inductor No. 89 mounted on pier C, No. 200 being on pier D; Mr. Menzies observed alternately with the two instruments, but stations were not exchanged. From 22 sets it was found that the correction of Dover No. 200 on this earth inductor was $+0'.11$, hence:

IX. Agincourt earth inductor No. 89 — Dover No. 200 = $+0'.1$.

From VII and IX we get for 1910 to 1912, assuming no changes in the dip circles used in the comparisons, and that the station-differences are negligible quantities:

X. C. I. W. — Agincourt earth inductor No. 89 = $+0'.3$.

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(1) I. M. S. — Agincourt (Toronto declinometer) = $-1'.1$? (1906–10).

(1*a*) I. M. S. — Agincourt (Elliott magnetometer No. 98) = $+0.00008H$ (1911).

(1*b*) I. M. S. — Agincourt (Toepfer inductor No. 89) = $+0'.8$ (1910–12).

NO. 2.—ALGIERS OBSERVATORY, BOUZAREAH, ALGERIA.

Comparisons were secured at the Algiers Observatory (Bouzareah Observatoire d'Alger) by Observer W. H. Sligh in January 1912, and again in November and December of the same year; the instruments used by him were C. I. W. magnetometer No. 7 and Dover dip circle No. 202 with needles 1 and 2. The observations were made at 3 stations, designated, O, M, and M_2.

O, the principal station, is the pier in the magnetic hut of the Observatory, this hut being about 50 meters distant from the nearest building; the pier, which is of stone, is set in a cement floor and has a marble top. M is the station where Professor Moureaux had made his observations; it is about 300 meters distant from O, and is on the hillside at a place leveled off for observational work, about 150 meters west of the Observatory grounds. M was marked by Mr. Sligh with a wooden peg about 4 centimeters in diameter and about 40 centimeters long; the exact point is the brass tack in the top of the peg. M_2 was an auxiliary station, used by Mr. F. Baldet, of the Observatory staff, in some of his observations and by Observer H. E. Sawyer, of the Department of Terrestrial Magnetism, on October 10, 1912, while making special magnetic observations on the day of the eclipse. Mr. Sawyer marked the spot by a round wooden peg nearly 4 centimeters in diameter driven flush with the ground and having a brass tack in the top. M_2 is on the first rise west of the Observatory and on the same hill occupied by it; it is, furthermore, on the brow of the hill overlooking station M and is about 60 meters west of the latter.

The mark used at O for the declination observations was Matifou Phare (Lighthouse) about 19 kilometers distant, its azimuth, as supplied by the Observatory, being 265° 28′.5 W. of S. The mark used throughout at M was the Dome de Kouba, about 12 kilometers distant; its azimuth, as determined by Mr. Villatte, of the Observatory, by stellar observations, was 322° 46′.7 W. of S. The mark sighted from M_2 was the Dome de Kouba; its azimuth was 322° 28′.6 W. of S., as determined from solar observations by Messrs. Baldet, Sligh, and Sawyer.

Mr. N. Villatte used for the comparisons the Echassoux magnetometer, the constants of which were not definitely known. After the first series of comparisons, made on January 5 and 11, he remagnetized the two magnets of his instrument on January 24. An examination made after these first comparisons showed that certain parts of the instrument were magnetic.

Mr. Baldet observed with the Brunner Frères magnetometer and with the Laderrière dip circle, both instruments being of the very small portable type and having been used formerly by Mr. d'Abbadie. During the declination observations on January 12, he inadvertently allowed the two magnets of the magnetometer to come in contact and thus incurred the possibility of a change in his instrumental constants.

In view of these mishaps and changes, it is not deemed worth while to publish in detail the January series of magnetometer comparisons. The mean results are as follows:

TABLE 2A.—*C. I. W.—Algiers (January 1912).*

Date	Echassoux magnetometer			Brunner magnetometer	
	Declination		Horizontal intensity	Decl'n	Horizontal intensity
	Magnet I	Magnet II	Magnet I	Magnets I & II	Magnet I
1912	′	′		′	
Jan. 5, 11	−3.6	−4 1	−39 8γ=−0.00156H	......	....
5, 12	.....	.....	....	+2.5	....
5, 13	.....	......	....	.....	+12γ=+0.00047H[1]

[1]Only one observation, hence not much value to be attached to the result.

TABLE 2 B.—*Results of Declination Comparisons at the Algiers Observatory, November–December 1912.*

Date	Local mean time		Declination obtained[1]				C. I. W.—Algiers			Remarks
	From	To	C. I. W.	Ech I	Bru. I	Bru. II	Ech I	Bru I	Bru II	
1912	h m	h m	° ′	° ′	° ′	° ′	′	′	′	
Nov 30	10 44	10 53	−11 41 4		−11 39 4			−2 0		C. I. W. at *M*; Brunner at *O*
30	11 07	11 16	41 9			−11 40 0			−1 9	
30	11 36	11 45	42 4			40 3			−2 1	
30	11 55	12 04	42 1		40 8			−1 3		
Dec 5	9 39	9 48	38 7	−11 38 8			+0 1			C I W at *M*, Echassoux at *O*
5	9 59	10 08	39 3	40 1			+0 8			
6	13 51	14 00	39 1		38 8			−0 3		C. I W at *O*, Brunner at *M*.
6	14 02	14 11	38 6		38 3			−0 3		
6	14 18	14 27	38 8			37 7			−1 1	
6	14 29	14 38	38 3			38 0			−0 3	
9	14 21	14 55	39 0	39 1			+0 1			C I. W. at *O*, Echassoux at *M*
9	15 06	15 15	38 7	39.0			+0 3			
Hence mean values C. I. W.—Algiers (Echassoux I)							+0 3			
C I. W—Algiers (Brunner I)								−1 0		
C. I. W.—Algiers (Brunner II)									−1 4	

[1]All values are referred to station *O*, $O=M-3'.6$.

TABLE 2 C.—*Results of Horizontal-Intensity Comparisons at the Algiers Observatory, November–December 1912.*

Date	Local mean time		Horizontal intensity obtained[1]				C. I. W.—Algiers			Remarks
	From	To	C.I.W.	Ech I	Bru. I	Bru. II	Ech I	Bru I	Bru II	
1912	h m	h m	γ	γ	γ	γ	γ	γ	γ	
Dec 5	10 22	11 19	25427	25419			+8			C I W. at *M*, Ech at *O*.
5	11 38	12 27	421	421			0			
5	13 24	14 18	403	384			+19			
10	9 45	10 44	439	454			−15			C. I W at *O*, Ech at *M*
10	10 49	11 35	437	427			+10			
10	13 44	14 33	434	405			+29			
Nov. 30	14 22	15 47	25440		25445			−5		C I. W at *M*; Bru at *O*
Dec 3	9 18	10 29	438		425			+13		
3	10 21	11 14	426		427			−1		
3	13 40	14 44	429			25435			−6	
7	10 57	11 54	438		443			−5		C. I. W at *O*, Bru. at *M*
7	13 26	14 31	415		424			−9		
9	9 55	10 56	423			425			−2	
9	10 50	11 51	424			410			+14	
						Mean	+8 5	−1 4	+2 0	

[1]All are referred to station *O*, $O=M$ for comparisons with Echassoux magnetometer, whereas for Brunner magnetometer $O=M+24\ 6\gamma$ The cause for this discrepancy in the station-difference as shown by the two different magnetometers is not at present known. Owing to the fact that, in each set of comparisons, the observers exchanged stations, any error in the assumed station-difference is eliminated in the final result for the correction of the Echassoux or of the Brunner magnetometer on the C. I. W. standard.

By comparison with the January results, it will be seen that the *H*-correction of the Echassoux magnetometer (Magnet I) on the C. I. W. standard has been changed, since the remagnetization of the magnets, from -39.8γ to $+8.5\gamma$, or from $-0.00156H$ to $+0.00033H$. The correction for the Brunner magnetometer on the C. I. W. standard, as judged by the limited number of results, is practically the same for both magnets; taking the mean of the two, we have (C. I. W.—Brunner, Magnets I and II) $= +0.3\gamma$. The constant for the Brunner instrument was determined relative to the standard at Val Joyeux from observations made there on December 6, 1911; however, as no corrections were applied to the Observatory

results on account of change in the induction correction with H and because of change in the constant with temperature, the perfect agreement of the Brunner magnetometer with the C. I. W. standard must be regarded as fortuitous.

The change in the declination-correction on the C. I. W. standard of the Echassoux magnetometer (Magnet I) from $-3'.6$ (January) to $+0'.3$ (December) may have to be attributed to instrumental changes. However, the declination correction for the Brunner magnetometer also changed from $+2'.5$ (January) to $-1'.2$ (November-December).

TABLE 2 C—*Results of Inclination Comparisons at the Algiers Observatory, January and December 1912.*

Date	Local mean time		Inclination obtained[1]				C. I W —Algiers			Remarks
	From	To	C. I W.	Algiers			Needle			
				I	II	Mean	I	II	Mean	
1912	h m	h m	° ′	° ′	′	′	′	′	′	
Jan. 6	9 16	11 00	+52 59 6	+52 64 2	60 1	62 2	−4 6	−0 5	−2 6	C. I W at *M*, Algiers at *O*.
6	14 56	16 14	60 2	65 5	62 0	63 8	−5 3	−1 8	−3 6	
9	9 41	10 43	62 8	67 9	60 1	64 0	−5 1	+2 7	−1 2	
9	11 32	12 30	61 0	67 7	61 7	64 7	−6 7	−0 7	−3 7	C. I. W. at *O*, Algiers at *M*.
9	14 33	15 30	59 6	65 7	61 4	63 6	−6 1	−1 8	−4 0	
9	15 42	16 45	61 2	67 5	63 5	65 5	−6 3	−2 3	−4 3	
						Mean	−5 7	−0 7	−3 2	
Dec 4	9 40	10 51	+52 55 2	+52 64 6	63 6	64 1	−9 4	−8 4	−8 9	C I W. at *M*, Algiers at *O*.
4	11 06	12 07	58 8	68 5	63 4	66 0	−9 7	−4 6	−7 2	
4	14 12	15 06	56 3	65 2	68 9	67 0	−8 9	−12 6	−10 7	C I W at *O*, Algiers at *M*.
4	15 15	16 07	60 4	61 5	64 2	62 8	−1 1	−3 8	−2 4	
						Mean	−7 3	−7 4	−7 3	

[1]All are referred to station O, $O=M-0'\ 2$.

We thus obtain [C. I. W.—Algiers (Laderrière D. C., needles I and II)] equal to $-3'.2$ (Jan. 1912), and equal to $-7'.3$ (Dec. 1912). It would appear that there has been some change in the Observatory dip circle, especially in needle II, between January and December 1912.

In view of the uncertainties in the results due to various changes, the reductions to I. M. S. (see p. 273) are omitted.

NO. 3.—ALIBAG OBSERVATORY, NEAR BOMBAY, INDIA.

The results of comparisons of standards given below were obtained incidentally to other duties. The observations made March 22–24, 1911, at the Alibag Observatory, by Observer W. H. Sligh, of the Department of Terrestrial Magnetism, were secured by him while passing through Bombay in the course of a magnetic field trip. He used C. I. W. magnetometer No. 7 and Dover dip circle No. 202 with needles 1 and 2. W. V. Nene, of the Observatory, made observations simultaneously with him, using Cooke magnetometer No. 7 and dip circle No. 160, made by the Cambridge Scientific Instrument Company.

Two stations were occupied in the absolute observatory, which are designated as Upper Pier (U) and Lower Pier (L). U is the central sandstone pier, with marble top, on the second observing floor of the building, and is the pier regularly used for observations of declination and of horizontal intensity; the one directly south of it is a wooden pier (U_s) and was used for the dip-circle observations. The earth-inductor observations are made on the pier about north of U and the accompanying galvanometer is mounted about 3.5 feet northwest of U. L is the solitary stone pier, with marble top, on the first observing floor of the building; it is used for D, I, and H observations; the Observatory published values are all referred to U.

The corrections to be applied to the observations at L to refer them to U, according to the data given by the Observatory, are: $+1'.4$ for declination (*i. e.*, east declination is

1'.4 higher at U than at L), and 0γ for horizontal intensity and 0'.0 for inclination. Owing to the method of observation adopted, the station corrections do not enter except for the L observations on September 19–21, when magnetograph values referred to the lower pier had to be used, the values originally supplied referring to the upper pier.

The same azimuth mark (Kennery lighthouse) is used at both U and L, the azimuth being the same, viz, 137° 53'.4 W. of S.

TABLE 3 A.—*Results of Magnetic Observations at the Alibag Observatory, March 22–24 and September 19–21, 1911.*

[The magnetograph values are derived from the magnetograph ordinates standardized by observations of declination and horizontal intensity with Cooke magnetometer No. 7 and by observations of inclination with Cambridge dip circle No. 160.]

Station	Date	Local mean time		Declination		Date	Local mean time		Hor. intensity		Date	Local mean time		Inclination	
		From	To	Cooke 7	Mag'ph		From	To	Cooke 7	Mag'ph		From	To	D.C 160	Mag'ph
	1911	h m	h m	° '	° '	1911	h m	h m	γ	γ	1911	h m	h m	° '	° '
Upper Pier	Mar. 23	8 30	8 39	+0 56 7	+0 56.1	Mar. 23	9 28	11 14	36855	36860	Mar. 22	12 31	13 19	+23 43 8	+23 44 4
	23	11 21	11 30	55.6	54 6	23	13 09	14 44	840	839	22	13 25	14 11	45 0	45 1
	23	12 56	13 05	54.2	53 6	...	...	...	...	...	...	...	...	...	...
	23	14 52	15 01	55.1	54 6	...	...	...	...	...	...	...	...	...	...
Lower Pier	Mar. 23	15 51	16 00	+0 54 4	+0 55.3	Mar. 23	16 06	17 39	36844	36839	Mar. 22	15 33	16 22	+23 46 0	+23 45 7
	23	17 45	17 54	54 2	54.6	24	8 29	9 06	841[1]	846	22	16 25	17 13	46 4	45.8
	24	7 25	7 34	55 1	55 8	...	...	...	...	...	...	...	...	...	...
	24	9 11	9 20	55 2	56.2	...	...	...	...	...	...	...	...	...	...
Upper Pier	Sept. 19	14 06	14 17	...	+0 53 0	Sept. 19	14 25	15 21	...	36878	Sept. 19	16 14	17 18	...	+23 47 8
	19	15 29	15 38	...	53 9	20	8 13	9 11	...	835	20	10 20	11 20	...	48.2
	20	7 58	8 07	...	55.2	21	7 44	8 40	...	845	...	...	...	...	...
	20	9 43	9 54	...	52.2	21	9 14	10 01	...	862	...	...	...	...	...
	21	7 32	7 42	...	55 8	...	...	...	...	...	...	...	...	...	...
	21	8 40	8 49	...	55.2	...	...	...	...	...	...	...	...	...	...
	21	9 04	9 13	...	54.8	...	...	...	...	...	...	...	...	...	...
	21	10 02	10 11	...	53.4	...	...	...	...	...	...	...	...	...	...

[1]Only second half of full set; the first half had to be omitted, as direct rays of the Sun fell upon the instrument, making temperature corrections uncertain.

TABLE 3 B.—*Results of Declination Comparisons at the Alibag Observatory, 1911.*

Station	Date	Local mean time		Declination obtained		C.I.W.—Alibag	Remarks
		From	To	C. I. W.	Alibag		
	1911	h m	h m	° '	° '	'	
Upper Pier	Mar. 23	15 51	16 00	+0 56.4	+0 55 9	+0 5	C. I. W. No. 7, Alibag observations were made with Cooke No 7 on Mar. 23 and referred to C. I. W. observations by means of magnetograph.
	23	17 45	17 54	57 2	55 6	+1.6	
	24	7 25	7 34	56.8	56.4	+0 4	
	24	9 11	9 20	58 6	56 7	+1 9	
	Sept. 19	14 06	14 17	52 8	53 0	−0 2	C. I. W. No 14, Alibag observations are magnetograph values standardized by Cooke No. 7.
	19	15 29	15 38	53.4	53 9	−0 5	
	21	9 04	9 13	54 4	54 8	−0 4	
	21	10 02	10 11	53 7	53.4	+0.3	
					Mean	+0.4	
Lower Pier	Mar. 23	8 30	8 39	+0 55 4	+0 55 2	+0 2	C. I. W. No. 7; Alibag observations were made with Cooke No. 7 on Mar. 23 and 24 and referred to C. I. W. observations by means of magnetograph.
	23	11 21	11 30	54 4	54.2	+0 2	
	23	12 56	13 05	53 0	52.9	+0.1	
	23	14 52	15 01	54 6	53 6	+1.0	
	Sept. 20	7 58	8 07	54.2	53 8	+0 4	C. I. W. No. 14; Alibag observations are magnetograph values referred to lower pier and standardized by Cooke No. 7.
	20	9 43	9 54	50.7	50 8	−0 1	
	21	7 32	7 42	54 2	54.4	−0 2	
	21	8 40	8 49	55 6	53.8	+1.8	
					Mean	+0.4	
Mean value of (C. I. W —Alibag) for both stations						+0.4	

The observations, September 19–21, by L. A. Bauer, were mainly for the purpose of testing the new, small universal magnetometer (No. 14) constructed by the Department of Terrestrial Magnetism. They were incidental to his visit to the Observatory. In the absence of simultaneous observations, the Observatory values are the standardized magnetograph ones.

The data supplied by the Observatory are given in Table 3 A and the results of comparisons in Tables 3B, 3C, and 3D.

TABLE 3 C.—*Results of Horizontal-Intensity Comparisons at the Alibag Observatory, 1911.*

Station	Date	Local mean time		Horizontal intensity obtained		C.I.W.−Alibag	Remarks
		From	To	C. I. W.	Alibag		
	1911	h m	h m	γ	γ	γ	
Upper Pier	Mar. 23	16 06	17 39	36794	36834	−40	C. I. W. No. 7; Cooke No. 7, observations Mar. 23 referred to C. I. W. observations by means of magnetograph.
	24	8 29	9 06	799	847	−48[1]	
	Sept. 19	14 26	15 22	848	878	−30	C. I. W. No. 14; Alibag magnetograph values standardized by Cooke No. 7.
	21	9 15	10 01	834	862	−28	
					Mean	−34.9	
Lower Pier	Mar. 23	9 28	11 14	36832	36865	−33	C. I. W. No. 7; Cooke No. 7, observations Mar. 23 and 24 referred to C. I. W. observations by means of magnetograph.
	23	13 09	14 44	803	834	−31[1]	
	Sept. 20	8 14	9 11	802	835	−33	C. I. W. No. 14; Alibag magnetograph values standardized by Cooke No. 7.
	21	7 45	8 40	810	845	−35	
					Mean	−33.3	
Mean value of (C. I. W.—Alibag) for both stations						−34.1γ or −0.00093H.	

[1]Weight 0.5 as this value is dependent partly upon observations when Sun shone on instrument, making temperature-corrections uncertain.

TABLE 3 D.—*Results of Inclination Comparisons at the Alibag Observatory, 1911.*

Station	Date	Local mean time		Inclination obtained		C.I.W.−Alibag	Remarks
		From	To	C. I. W.	Alibag		
	1911	h m	h m	° ′	° ′	′	
Upper Pier	Mar. 22	15 33	16 22	+23 45.0	+23 45.1	−0.1	C. I. W. No. 202; Alibag D. C. No. 160, observations Mar. 22 referred to C. I. W. observations by means of magnetograph.
	22	16 25	17 13	45.9	45.7	+0.2	
	Sept. 20	10 20	11 20	46.1	48.2	−2.1	C. I. W. No. 14; Alibag magnetograph values standardized by D. C. No. 160.
					Mean	−0.7	
Lower Pier	Mar. 22	12 31	13 19	+23 45.2	+23 44.7	+0.5	C. I. W. No. 202; Alibag D. C. No. 160, observations Mar. 22 referred to C. I. W. observations by means of magnetograph.
	22	13 25	14 11	44.6	45.7	−1.1	
	Sept. 19	16 14	17 18	46.9	47.8	−0.9	C. I. W. No. 14; Alibag magnetograph values standardized by D. C. No. 160.
					Mean	−0.5	
Mean value of (C. I. W.—Alibag D. C. 160) for both stations..						−0.6	

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(3) I. M. S.−Alibag (Cooke magnetometer No. 7)= +0′.3 (1911).

(3*a*) I. M. S.−Alibag (Cooke magnetometer No. 7)= −0.00108H (1911).

(3*b*) I. M. S.−Alibag (Cambridge dip circle No. 160)= −0′.1 (1911).

NO. 4.—ANTIPOLO OBSERVATORY, NEAR MANILA, PHILIPPINES.

The Observatory is located at Antipolo, about 18.5 kilometers east of Manila. Three stations were occupied: station *A* is the pier of the absolute observatory; stations *B* and *C* are on the broad road or walk in front of the variation observatory and in line with the small bungalow to the rear of the hotel. *B* is about 26 meters south of the southeast corner of the variation observatory, and is distant from *C* 26.71 meters. The marks used for the declination observations were a mark on the bungalow to the south and the Observatory mark on the mango tree 59.86 meters distant from *C*.

The absolute instruments used at the Observatory were, at the time: Elliott magnetometer No. 28, Dover dip circle No. 7 (needle No. 2), Coast and Geodetic Survey magnetometer No. 17, and Coast and Geodetic Survey dip circle No. 37 (needle No. 2). Mr. Césareo Dulueña, of the Observatory staff, observed with magnetometer No. 28 and dip circle No. 7; the other instruments, including the ones of the Coast and Geodetic Survey, were used by Observers H. M. W. Edmonds, H. D. Frary, and H. F. Johnston, of the *Carnegie*. The *Carnegie* instruments compared with were: C. I. W. magnetometer No. 4 and Schulze earth inductor No. 2.

The observations with Coast and Geodetic Survey magnetometer No. 17 and dip circle No. 37 showed that both instruments were in need of thorough overhauling. The lifting wyes of No. 37 required adjustment and rust spots were found on the pivots of the dip needle (No. 2). It is, accordingly, not worth while giving in detail the results of the comparisons with these two instruments. The mean results, when referred to I. M. S. (p. 273), are:

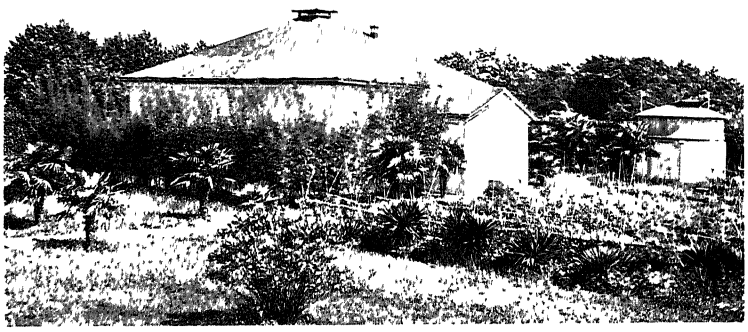
TABLE 4 A

Date	I. M. S.—Antipolo (C. & G. S. 17)		I. M. S.—Antipolo (C. & G. S. 37.2)
	Declination	Horizontal intensity	Inclination
1912 Feb. 10 to 22	+1′.7 (21 sets)	−0.00139*H* (3 5 sets)	+5′.6 (11 sets)

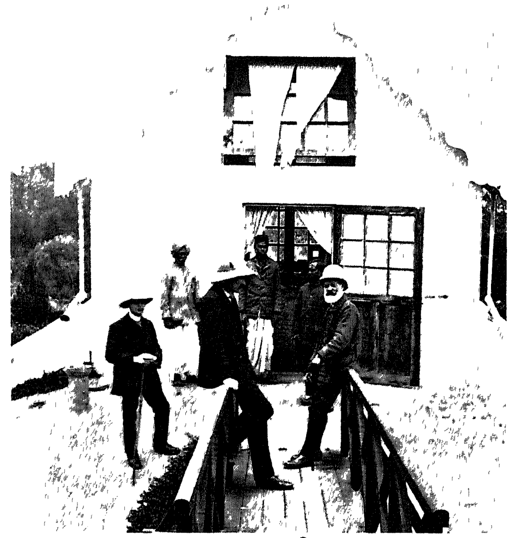
TABLE 4 B.—*Results of Declination Comparisons at the Antipolo Observatory, 1912*

Date	Local mean time		Declination obtained[1]		C.I.W.—Ant. 28	Station	
	From	To	C. I. W.	Ant. 28		C.I.W.	Ant. 28
1912	h m	h m	° ′	° ′	′		
Feb. 8	14 40	14 49	+0 41.1	+0 38.7	+2.4	*B*	*A*
8	16 12	16 21	41.2	39.8	+1.4	*B*	*A*
9	9 44	9 53	39.2	37.1	+2.1	*B*	*A*
9	11 13	11 22	38.3	36.2	+2.1	*B*	*A*
9	13 45	13 54	39.3	38.0	+1.3	*B*	*A*
9	15 10	15 19	40.4	38.1	+2.3	*B*	*A*
17	9 06	9 15	38.7	37.7	+1.0	*A*	*B*
19	14 01	14 10	38.7	37.6	+1.1	*A*	*B*
19	16 08	16 17	40.2	38.7	+1.5	*A*	*B*
20	8 54	9 03	38.8	35.9	+2.9	*A*	*B*
20	10 24	10 33	38.4	35.6	+2.8	*A*	*B*
20	10 55	11 04	38.0	36.0	+2.0	*A*	*B*
Mean value of (C. I.W. —Antipolo Mag'r 28)					+1.9		

[1]All values are referred to station *A* (observatory pier); *A* = *B* − 2′.3



1



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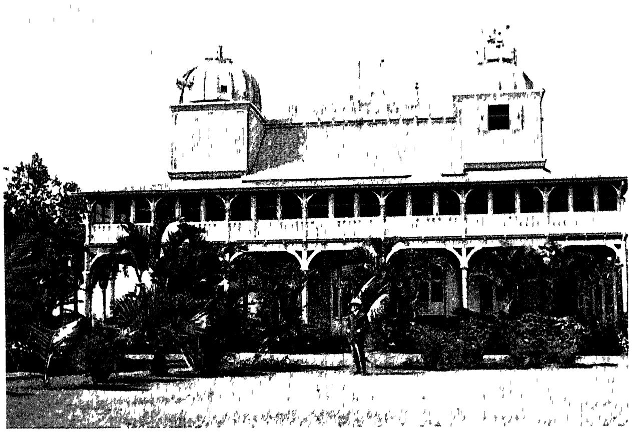

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6

Views of Magnetic Observatories in Asia, Mauritius, Java, and Philippines.

1. Zi-ka-wei, China.
2. Kodaikanal, India.
3. Batavia, Java.
4. Antipolo, near Manila, Philippines
5. Royal Alfred Observatory on Mauritius Island
6. Colaba, near Bombay, India.

TABLE 4C.—*Results of Horizontal-Intensity Comparisons at the Antipolo Observatory, 1912.*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Ant. 28	Station		Remarks
	From	To	C. I. W.	Ant. 28		C.I.W.	Ant. 28	
1912	h m	h m	γ	γ	γ			
Feb 8	15 13	16 07	38199	38284	−80	*B*	*A*	
9	10 01	10 54	228	302				
9	11 36	12 20	221	294	−86	*B*	*A*	
9	14 04	14 55	189	289				
17	9 31	10 25	214	301	−71	*A*	*B*	
19	15 19	16 05	211	266				
20	9 14	10 05	228	287	−59	*A*	*B*	Half set; weight 0.5.
Mean value of (C. I. W.—Antipolo Mag'r 28)					−76.1γ or −0.00199*H*.			

[1]All values are referred to station *A* (observatory pier), $A = B + 3\gamma$

TABLE 4D.—*Results of Inclination Comparisons at the Antipolo Observatory, 1912*

Date	Local mean time	Inclination obtained[1]		C.I.W.—Ant. 7,2	Station		Remarks
		C.I.W.	Ant D.C. 7,2		C.I.W.	Ant 7,2	
1912	h m	° ′	° ′	′			
Feb 13	10 51	+16 17.0	+16 15.8	+1.2	*C*	*A*	
13	11 49	16.9	16.1	+0.8	*C*	*A*	
13	14 18	18.2	17.5	+0.7	*C*	*A*	
13	14 56	18.3	19.9	−1.6	*C*	*A*	
13	15 29	18.7	18.8	−0.1	*C*	*A*	
13	16 11	19.1	18.9	+0.2	*C*	*A*	
13	16 38	19.5	18.0	+1.5	*C*	*A*	
14	8 40	18.0	19.3	−1.3	*A*	*C*	
14	9 15	17.0	12.9	+4.1	*A*	*C*	Rejected.
14	9 50	16.8	16.9	−0.1	*A*	*C*	
14	10 23	16.5	17.1	−0.6	*A*	*C*	
14	10 57	16.0	16.9	−0.9	*A*	*C*	
14	11 24	15.7	15.9	−0.2	*A*	*C*	
14	11 51	16.1	14.8	+1.3	*A*	*C*	
14	14 17	17.2	17.1	+0.1	*A*	*C*	
14	14 46	17.5	17.0	+0.5	*A*	*C*	
14	15 18	17.9	18.1	−0.2	*A*	*C*	
Mean value of (C.I.W.—Antipolo D.C. 7,2)				+0.1			

[1]All values are referred to station *A* (observatory pier), $A = C + 5'.7$

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(4) I. M. S.—Antipolo (Elliott magnetometer No. 28) = +1′.8 (1912).
(4*a*) I. M. S.—Antipolo (Elliott magnetometer No. 28) = −0.00214*H* (1912).
(4*b*) I. M. S.—Antipolo (Dover dip circle No. 7, needle 2) = +0′.6 (1912).

NO. 5.—ATHENS OBSERVATORY, ATHENS, GREECE.

The comparisons at the National Observatory of Greece, located at Athens, were secured under difficulties, owing to the close proximity of electric-car lines and electric-light and telephone wires; they were obtained in connection with Observer W. H. Sligh's field work. It is not deemed worth while to give more than the mean results of the comparisons made during the period August 11–22, 1911. The Observatory instruments were of the small, portable type by Chasselon, viz: Chasselon magnetometer No. 22 and Chasselon dip circle No. 16. The C. I. W. instruments were: C. I. W. magnetometer No. 7 and Dover dip circle No. 202 with needles 1 and 2, both instruments being referred to the C. I. W. standards. The mean results for 1911, referred to I. M. S. (p. 273), are:

(5) I. M. S.—Athens (Chasselon magnetometer No. 22) = −0′.1 (12 sets, 1911).
(5*a*) I. M. S.—Athens (Chasselon magnetometer No. 22) = −0.00236*H* ($5\frac{1}{2}$ sets, 1911).
(5*b*) I. M. S.—Athens (Chasselon dip circle No. 16) = +5′.7 (4 sets, 1911).

NO. 6.—BATAVIA OBSERVATORY, JAVA.

The following comparisons of the magnetic instruments of the Carnegie Institution of Washington with those of the Imperial Magnetic and Meteorological Observatory of Batavia were obtained in November 1911, when the magnetic-survey vessel, *Carnegie*, was at Batavia. The observations were all made at night in the absolute pavilion of the Observatory, after the electric cars had stopped running. The instruments used by the Observatory were: the reconstructed Meyerstein unifilar for declination, Schulze earth inductor No. 47 for inclination, and Jones magnetometer No. 1 for horizontal intensity. Those used by the observer of the Department of Terrestrial Magnetism, Dr. H. M. W. Edmonds, were: C. I. W. magnetometer No. 4 for declination and horizontal intensity, and Toepfer earth inductor (C. I. W. No. 2) for inclination; the results obtained with these instruments were referred to the C. I. W. standards. The observers for the Observatory were: Dr. W. van Bemmelen for declination, Mr. F. R. Rapp for horizontal intensity, and Dr. C. Braak and Mr. J. H. Kats for inclination.

The declinations were all obtained on the declination pier of the absolute pavilion, one instrument being dismounted while the other was used, the observations with the respective instruments following each other as closely as possible. The observations for horizontal intensity were made simultaneously on two piers, namely, the regular horizontal intensity pier of the Observatory, designated in the tables as *A*, and on the auxiliary pier designated as *C*; the observers exchanged stations in the middle of the series. Pier *A* is the northwest pier of the Observatory; pier *C* being distant from *A*, 5.75 meters to the south. The inclination observations were made alternately with each earth inductor, on the pier regularly used by the Observatory, the same galvanometer, Plath No. 207, serving for both; one instrument was removed to allow observations with the other, and the series of observations followed one another as quickly as possible.

TABLE 6 A.—*Results of Declination Comparisons at the Batavia Observatory, 1911.*

Date	Local mean time		Declination obtained		Declination reduced to scale division 70 of Wild variation unifilar		C. I. W.—Batavia
	From	To	C. I. W.	Batavia	C. I. W.	Batavia	
1911	h m	h m	° ′	° ′	° ′	° ′	′
Nov. 2	19 26	19 42	......	+0 47.4	......	+0 48.9	+0.5 (weight 2)
2	20 48	20 57	+0 47.4	......	+0 49.0	......	
2	22 02	22 11	47.8	......	49.7	......	
2	22 44	23 00	......	46 9	......	48.8	
3	19 01	19 18	......	47.2	......	48 8	+0.7 (weight 4)
3	19 22	19 40	......	47.1	......	48.9	
3	20 18	20 24	47 5	......	49.4	......	
3	20 28	20 34	48 1	......	50 0	......	
3	20 52	20 58	47.0	......	49 5	......	
3	21 03	21 11	46.9	......	49 3	......	
3	21 41	21 55	......	46.5	......	48 9	
3	21 57	22 14	......	46.4	......	48 7	
Weighted mean value of (C. I. W.—Batavia)........							+0 6

The adopted azimuth of the mark used in sighting from the magnetometer pier is 171° 22′.7 west of south. As will be noted in the tables, the absolute values obtained by the Observatory have been reduced, in the case of declination and inclination, to fixed readings of the Wild variometers. The Observatory values of horizontal intensity are all reduced to absolute values for the local mean time of the oscillation-sets; it may be noted, however, that the observations for horizontal intensity for both observers were practically

simultaneous. In obtaining the quantity (C. I. W. — Batavia), the observations on each day were, furthermore, grouped so as to eliminate as far as possible any outstanding effect on account of diurnal variation. The declination correction (+0′.4) for C. I. W. magnetometer No. 4 which was applied to the observations by Dr. Edmonds, is uncertain by 0′.1 or 0′.2. It is assumed that no error of consequence is to be attached to the value furnished Dr. Edmonds of the angle (2′ 52″) used in referring the azimuth of mark from theodolite pier to magnetometer pier.

TABLE 6B —*Results of Horizontal-Intensity Comparisons at the Batavia Observatory, 1911.*

Date	Local mean time		Horizontal intensity obtained[1]		C.I.W. — Batavia	Magnetometer station	
	From	To	C. I. W.	Batavia		C. I. W.	Batavia
1911	h m	h m	γ	γ	γ		
Oct 30	19 11	19 28	....	36671	+52 (weight 2)	......	A
30	19 12	20 35	36744	......		C	......
30	20 41	21 29	708	.....		C	......
30	21 17	21 35	....	676		......	A
31	19 04	19 15	.....	675	+48 (weight 2)	......	A
31	19 04	20 02	717	......		C	......
31	20 08	20 55	719	..		C	....
31	20 47	20 58	.....	666		....	A
Nov. 7	19 32	19 48	...	659	+49 (weight 2)	......	C
7	19 36	20 44	695	....		A	....
7	20 50	21 43	721	...		A	....
7	21 34	21 45	...	659		.....	C
8	20 08	20 18	...	664	+53 (weight 1)	...	C
8	20 09	21 02	717	....		A	.....
Weighted mean value of (C.I.W. — Batavia)					+50.1γ or +0 00137H		

[1]All values are referred to Observatory Pier A; $A = C - 9\gamma$.

TABLE 6C.—*Results of Inclination Comparisons at the Batavia Observatory, 1911.*

Date	Local mean time		Inclination obtained		Inclination reduced to fixed readings of Wild H and Z variometers		C I.W. — Batavia
	From	To	C. I. W.	Batavia	C. I. W.	Batavia	
1911	h m	h m	° ′	° ′	° ′	° ′	′
Nov. 4	19 07	19 44	...	−31 19.1	...	−31 18.8	−0 28 (weight 3)
4	19 49	20 30	.	19 4	....	19 0	
4	21 03	21 45	−31 19 4	...	−31 18 1	....	
4	21 47	22 22	19 6	...	18 2	....	
10	19 16	19 37	20 2	....	19 6	....	
10	19 41	20 04	19 8	.....	19.1	....	
10	20 27	20 58	....	18 0	....	17 6	
13	20 40	21 18	21 5	....	18.9	....	−0 38 (weight 3)
13	21 26	21 54	20 8	.	19.4	.....	
13	22 14	22 40	..	20 9	......	18.9	
13	22 50	23 08	....	20.0	......	18 8	
13	23 28	23 50	20 5	....	19 3	....	
13	23 54	24 16	19 7	....	19 0	....	
13	24 34	24 55	....	19 4	....	18.6	
Mean value of (C. I. W. — Batavia)........................							−0.3

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(6) I. M. S. — Batavia (Meyerstein unifilar) = +0′.5 (1911).

(6*a*) I. M. S. — Batavia (Jones magnetometer No. 1) = +0.00122H (1911).

(6*b*) I. M. S. — Batavia (Schulze inductor No. 47) = +0′.2 (1911).

NO. 7.—CHELTENHAM OBSERVATORY, MARYLAND.

All the observations at the Cheltenham Observatory of the United States Coast and Geodetic Survey have been made on the extra pier (B_t) in the west wing of the absolute house. Careful determinations made by the Observatory authorities indicate that there is no difference between the magnetic elements at this pier and those at the piers upon which the Observatory instruments are mounted.

The standard instruments at this Observatory are the large Wild-Edelmann instruments, consisting of declinometer, earth inductor, and magnetometer, No. 26. The declinometer with large theodolite, for determining the declination, and the earth inductor with its galvanometer, for determining the inclination, are in the east wing of the absolute house, while the magnetometer for determining the horizontal intensity is in the west wing. The Cheltenham Observatory is the magnetic base station of the United States Coast and Geodetic Survey and fixes also the standards for the magnetic observatories of that Bureau at Honolulu, Vieques (Porto Rico), Baldwin (Kansas, now discontinued and superseded by Tucson, Arizona), and Sitka (Alaska).

The instruments used by the C. I. W. observers are as indicated in the column of remarks in the following tables.

The Observatory values of D and H for series I, II, and III, as supplied by the Superintendent of the United States Coast and Geodetic Survey, were scaled from the magnetograms, the base-lines of which were determined by aid of the observations with the standard instruments, made before and after the comparisons. For series IV, the observations were made as follows: The declinations were observed simultaneously with C. I. W. magnetometer No. 3 and the Observatory declinometer; for horizontal intensity, the observations with the 2 instruments, C. I. W. No. 3 and the Observatory magnetometer, No. 26, were made alternately, the results with the latter being referred to the mean time of the values with the former by means of the Observatory magnetograms.

For the inclination comparisons, simultaneous observations were invariably made with the C. I. W. instruments and the Observatory earth inductor. Observer J. C. Pearson, before and after extensive field work, compared Dover dip circle No. 177 (needles 1, 2, 5 and 6) with the Cheltenham earth inductor, the correction on C. I. W. standard being determined at Washington before and after the comparisons; thus series I and III were obtained. Furthermore, direct comparisons of the C. I. W. standard inclination instrument (Schulze earth inductor No. 48 with correction of $-0'.5$ applied) were obtained by Mr. H. W. Fisk in March and April 1908 (series II), under varied conditions and for various orientations of footscrews of No. 48, and by Dr. H. M. W. Edmonds in November 1913. The last series may have been affected by some disturbing cause, or there may have been some instrumental change, the possibility of which is being further investigated.[1]

In addition to the comparisons, 1908–1913, some also were secured during the years 1905–1907. As the results obtained during that period were intended primarily for standardizing the magnetic instruments used by the Department of Terrestrial Magnetism, before its own standards could be definitely decided upon, they are not given here.

[1]As this volume is passing through the press, we have before us the results of additional inclination comparisons made in June 1915, which confirm the 1913 results Some change appears to have taken place with regard to the Cheltenham earth inductor between 1910 and 1913.

TABLE 7 A —*Results of Declination Comparisons at the Cheltenham Observatory, 1908–1913.*

Series	Date	Local mean time		Declination obtained		C. I. W.—Cheltenham	Remarks
		From	To	C. I W	Cheltenham		
	1908	h m	h m	° ′	° ′	′	
I	Feb 5	13 32	13 41	−5 31 2	−5 31 9	+0 7	
	5	15 33	15 42	35 4	36 0	+0 6	
	6	8 08	8 14	25 6	25 5	−0.1	
	6	10 16	10 22	26 0	26 4	+0.4	
	6	11 40	11 47	27 7	28 2	+0.5	
	7	11 13	11 20	26 5	26 0	−0.5	C. I. W. magnetometer No 5 used; observer, J. C. Pearson.
	7	14 19	14 26	32 2	32 3	+0 1	
	7	14 34	14 40	33 3	33.1	−0.2	
	7	15 56	16 03	30 7	31 6	+0.9	
	7	16 06	16 13	31 3	31.9	+0 6	
	7	16 16	16 22	31 6	32.2	+0 6	
	8	8 34	8 40	25 1	25 2	+0 1	
	8	10 28	10 34	25 0	24.9	−0 1	
Mean value of (C. I. W —Cheltenham) . .					.	+0 28	(weight, 1 0)
II	Mar. 24	11 18	11 27	−5 29 6	−5 29.4	−0 2	
	24	15 16	15 25	32 8	32 7	−0 1	
	24	15 39	15 45	32 8	32 5	−0 3	
	25	7 51	8 00	25 7	25 8	+0 1	C I W magnetometer No. 7 used, observer, H W. Fisk
	25	10 12	10 21	27 3	26 9	−0 4	
	25	14 42	14 50	34 6	34 7	+0 1	
	25	16 26	16 35	32 9	33 1	+0 2	
	26	7 53	8 02	27 2	27 2	0 0	
Mean value of (C. I. W —Cheltenham)					.	−0 08	(weight, 1 0)
	1910						
III	Apr 5	13 04	13 13	−5 46 1	−5 46 2	+0 1	
	5	14 39	14 48	44 8	45 0	+0 2	
	5	15 00	15 09	44 5	44 4	−0 1	
	5	16 30	16 39	41.5	41 9	+0 4	
	6	7 25	7 34	36 7	37 0	+0 3	
	6	9 22	9 31	37 4	37 4	0 0	C I. W. magnetometer No 5 used; observer, J C. Pearson.
	6	9 41	9 50	38 0	38 2	+0 2	
	6	11 13	11 22	43 4	43 8	+0 4	
	6	11 37	11 46	44 8	44 5	−0 3	
	6	14 38	14 47	44 5	44 9	+0 4	
	6	14 57	15 06	44 1	44 2	+0 1	
	6	16 28	16 37	40 7	40 9	+0 2	
Mean value of (C I. W —Cheltenham)						+0 16	(weight, 1 0)
	1913						
IV	Nov 18	11 31	11 40	−5 57 7	−5 58 6	+0 9	
	18	15 18	15 27	57 3	57 8	+0 5	
	18	15 36	15 45	57 2	57 8	+0 6	
	19	11 24	11 33	57 7	57 7	0 0	
	19	14 41	14 50	58 1	58 8	+0 7	
	19	14 56	15 05	57 9	58 7	+0 8	
	20	8 43	8 52	55 0	54 8	−0 2	
	20	8 59	9 08	55 0	54 8	−0 2	
	20	11 16	11 25	58 1	58 3	+0 2	
	20	11 29	11 38	58 4	58 5	+0 1	C. I W. magnetometer No 3(standard)used; observer, H. M W. Edmonds.
	21	11 24	11 33	58 7	58 8	+0 1	
	21	11 37	11 46	58 9	59 2	+0 3	
	21	14 50	14 59	58 0	58 6	+0 6	
	21	15 04	15 13	57 7	58 2	+0 5	
	22	8 31	8 40	53 6	53 8	+0 2	
	22	8 44	8 53	54 0	53 8	−0 2	
	22	11 14	11 23	58 0	58 2	+0 2	
	22	11 27	11 36	58 6	58 8	+0 2	
	23	8 56	9 05	54 5	55 2	+0 7	
	23	9 09	9 18	54 2	55 0	+0 8	
	23	10 54	11 03	57.1	57 4	+0 3	
	23	11 07	11 15	57 9	57 8	−0 1	
Mean value of (C. I. W.—Cheltenham) .					.	+0 32	(weight, 1.5)

Hence we get from the four series the weighted mean value: *C. I. W.—Cheltenham = +0′.19 for 1908–1913*).

TABLE 7 B.—*Results of Horizontal-Intensity Comparisons at the Cheltenham Observatory, 1908–1913.*

Series	Date	Local mean time		Hor. int. obtained		C. I. W.—Cheltenham	Remarks
		From	To	C. I. W.	Cheltenham		
	1908	h m	h m	γ	γ	γ	
I	Feb. 5	13 47	15 30	19936	19951	−15	C. I. W. magnetometer No. 5 used; observer, J. C. Pearson.
	5	15 55	17 04	926	946	−20	
	6	8 18	10 07	930	946	−16	
	6	10 25	11 33	902	919	−17	
	7	11 22	14 09	902	925	−23	
	7	14 43	15 52	912	935	−23	
	8	8 44	10 20	939	954	−15	
Mean value of (C. I. W.—Cheltenham)						−18.4γ or −0.00092H (weight, 1.0)	
II[1]	Mar. 24	13 28	15 10	19931	19950	−19	C. I. W. magnetometer No. 7 used; observer, H. W. Fisk.
	24	15 51	16 56	940	965	−25	
	25	8 13	9 35	930	954	−24	
	25	12 56	14 29	947	964	−17	
	25	14 57	16 17	956	976	−20	
	26	8 13	9 35	938	960	−22	
	26	10 40	11 38	938	949	−11	
	27	8 17	9 27	922	933	−11	
Mean value of (C. I. W.—Cheltenham)						−18.6γ or −0.00093H (weight, 1.0)	
	1910						
III	Apr. 5	13 22	14 37	19817	19831	−14	C. I. W. magnetometer No. 5 used; observer, J. C. Pearson. (Since this series, extensive field work and repairs.)
	5	15 14	16 28	831	846	−15	
	6	7 37	9 21	810	824	−14	
	6	9 53	11 11	790	806	−16	
	6	13 04	14 35	816	826	−10	
	6	15 09	16 23	822	838	−16	
Mean value of (C. I. W.—Cheltenham)						−14.2γ or −0.00072H (weight, 0.5)	
	1913						
IV	Nov. 18	13 14	15 01	19575	19589	−14	C. I. W. magnetometer No. 3 (standard) used; observer, H. M. W. Edmonds.
	19	7 32	8 52	564	579	−15	
	19	13 03	14 17	568	579	−11	
	20	7 20	8 34	567	585	−18	
	20	14 33	15 44	580	595	−15	
	21	7 25	8 42	575	594	−19	
	21	13 20	14 42	574	593	−19	
	22	7 17	8 29	570	583	−13	
	22	13 15	14 36	562	582	−20	
	23	7 31	8 47	568	587	−19	
	23	13 14	14 36	579	596	−17	
Mean value of (C. I. W.—Cheltenham)						−16.4γ or −0.00084H (weight 2.0)	

[1]Two sets, one on March 26 and the other on March 27, were omitted because they were made during a period of magnetic disturbance.

Hence, we get from the four series the weighted mean value: *C. I. W.—Cheltenham = −0.00086H (1908–1913).*

TABLE 7 C.—*Results of Inclination Comparisons at the Cheltenham Observatory, 1908–1913.*

Series	Date	Local mean time		Inclination obtained		C. I. W.−Cheltenham	Remarks
		From	To	C. I. W.	Cheltenham		
	1908	h m	h m	° ′	° ′	′	
I	Feb. 4	10 42	11 50	+70 31.2	+70 31.5	−0 3	Dover dip circle No. 177; observer, J. C. Pearson
	5	8 52	10 51	30 5	30.0	+0 5	
	6	14 10	15 54	31 5	30.6	+0 9	
	7	8 42	10 30	30 7	30 3	+0.4	
Mean value of (C. I. W.−Cheltenham) .. .						+0 4	(weight, 0 5)
II	Mar. 31	15 18	16 12	+70 30 4	+70 30 9	−0 5	C. I. W. earth inductor No. 48, observer, H. W. Fisk.
	31	16 23	16 59	30 9	30 6	+0 3	
	Apr. 1	8 24	9 11	32.9	33 0	−0 1	
	1	9 23	10 17	33 5	33 1	+0 4	
	1	13 38	14 07	30 6	31 0	−0 4	
	1	14 12	14 48	30 4	30 4	0 0	
	1	14 56	15 24	30 6	30 6	0 0	
	1	15 53	16 16	31 2	31 1	+0 1	
	2	8 29	9 06	32 6	32 4	+0 2	
	2	9 11	9 39	33 2	32 8	+0 4	
Mean value of (C. I. W.−Cheltenham)......						0.0	(weight, 3.0)
	1910						
III	Apr. 7	8 16	9 24	+70 35 5	+70 35 8	−0 3	Dover dip circle No. 177; observer, J. C. Pearson.
	7	10 09	11 15	36 2	35 9	+0 3	
	7	13 00	14 21	35 9	35 3	+0 6	
	7	15 34	16 48	34.2	34 6	−0 4	
	8	8 10	9 18	35 9	35 9	0 0	
	8	10 12	11 13	36 1	36 4	−0 3	
Mean value of (C. I. W.−Cheltenham)......... .						0 0	(weight, 1 0)
	1913						
IV	Nov. 20	9 56	10 29	+70 43 0	+70 42 0	+1 0	C. I. W. earth inductor No 48; observer, H. M. W. Edmonds.
	20	10 37	11 00	43 0	42 2	0 8	
	20	16 09	16 38	42 1	41 2	0 9	
	21	10 02	10 29	42.6	41 5	1 1	
	21	10 37	11 00	42 8	41 8	1.0	
	21	15 31	15 57	42 1	41 2	0 9	
	21	16 11	16 32	42 2	41 2	1 0	
	22	9 19	9 48	43 4	42 1	1 3	
	22	10 01	10 27	43 5	42 5	1 0	
	22	10 33	10 57	43.7	42 8	0 9	
	22	15 01	15 22	42 5	41 3	1 2	
	22	15 30	15 49	42.4	41 3	1 1	
	22	16 13	16 31	42 3	41 4	0.9	
Mean value of (C. I. W.−Cheltenham).. . .						+1 0	(weight, 1.0)

Hence, we get from the four series, the weighted mean value: *C. I. W.−Cheltenham* = $+0'.2$ *(1908–1913)*. See footnote on p. 226.

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(7) I. M. S.−Cheltenham (Wild-Edelmann declinometer No. 26) = $+0'.1$ (1908–13).

(7*a*) I. M. S.−Cheltenham (Wild-Edelmann magnetometer No. 26) = $-0.00101H$ (1908–13).

(7*b*) I. M. S.−Cheltenham (Wild-Edelmann inductor No. 26) = $+0'.7$ (1908–13).

NO. 8.—CHRISTCHURCH OBSERVATORY, NEW ZEALAND.

The comparisons at the Christchurch Observatory, 1906–1908, were carried out at the east and west piers of the absolute house (the east pier is used regularly by the Observatory for declination and intensity and the west pier for dip), and at several stations in the Observatory inclosure. A careful examination made by the Observatory over the inclosure showed that no measurable station-differences existed. The outside station of 1906 was designated "Peg II" and was 40 feet east-northeast of east pier in absolute house. In December 1907 and January 1908 the outside stations were: "Peg A," 40 feet east-north-

east of absolute house (probably nearly the same as "Peg II" of 1906); "Brass pipe," 150 feet northeast of absolute house, and "Near brass pipe," somewhat east-southeast of "Brass pipe." The Observatory standards were: Kew magnetometer No. 1 and Dover dip circle No. 147, needles 1, 2, 3. For series I (1906) the comparisons in horizontal intensity are not given because the observations by Observer Heimbrod with Tesdorpf magnetometer No. 2025 (deflections only) were used for determination of the intensity-constant, as based on the H-difference, (C. I. W. − Christchurch) determined from series II. In series II the Christchurch values, supplied by Director H. F. Skey, were scaled from the magnetograms the base-lines of which were determined with the Observatory absolute instruments (Kew magnetometer No. 1 and Dover dip circle No. 147). The C. I. W. values of horizontal intensity for series II were each derived from 1 set of deflections combined with 2 sets of oscillations.

The comparisons 1907–08 were obtained at the time of the visit of the magnetic-survey vessel *Galilee* to Port Lyttelton.

TABLE 8 A.—*Results of Declination Comparisons at the Christchurch Observatory, 1906–1908.*
(Magnetometers used by C. I. W. observers. Tesdorpf No. 2025 for series I and C. I. W. No. 4 for series II.)

Series	Date	Local mean time		Declination obtained[1]		C. I. W. − Christchurch	Remarks
		From	To	C. I. W.	Christchurch		
	1906	h m	h m	° ′	° ′	′	
I	July 9	11 09	11 27	+16 27.3	+16 25.6	+1.7	Mag'r No. 2025 at absolute house, east pier.[2]
	9	12 15	12 32	28.1	27.9	+0.2	
	9	14 17	14 33	31.4	30.8	+0.6	
	21	10 23	10 46	28.3	27.2	+1.1	
					Mean	+0.9	(weight, 1.0)
	1907						
II	Dec. 31	11 15	11 24	+16 33.4	+16 32.1	+1.3	C. I. W. No. 4 at tent station, brass pipe.
	31	13 00	13 09	38.9	37.4	+1.5	
	31	15 29	15 38	37.5	36.3	+1.2	C. I. W. No. 4 at absolute house, east pier.
	31	17 21	17 30	34.0	32.7	+1.3	
	1908						
	Jan. 3	15 13	15 22	38.1	36.8	+1.3	C. I. W. No. 4 at absolute house, east pier
	3	17 04	17 13	35.7	34.4	+1.3	
	4	11 16	11 25	34.9	33.9	+1.0	C. I. W. No. 4 at tent station, brass pipe
	4	12 51	13 00	40.3	38.9	+1.4	
	6	15 35	15 44	40.9	39.6	+1.3	C. I. W. No. 4 at absolute house, east pier
					Mean	+1.3	(weight, 3.0)
Weighted mean value of (C. I. W. − Christchurch) from I and II						+1.2	

[1]There is no appreciable station-difference.
[2]Simultaneous observations by Mr. Skey with Kew magnetometer No. 1, station not designated, but probably peg II.

TABLE 8 B.—*Results of Horizontal-Intensity Comparisons at the Christchurch Observatory, 1907–1908.*
(Magnetometer used by C. I. W. observer: C. I. W. No. 4.)

Date	Local mean time		Hor. int. obtained[1]		C. I. W. − Christchurch	Remarks
	From	To	C. I. W.	Christchurch		
1907	h m	h m	γ	γ	γ	(Station for C. I. W. No. 4.)
Dec. 31	11 41	12 38	22578	22559	+19	Tent station, brass pipe
31	16 22	17 10	618	601	+17	Absolute house, east pier.
1908						
Jan. 3	15 40	16 15	624	611	+13	Absolute house, east pier.
4	11 37	12 21	599	575	+24	Tent station, brass pipe.
4	14 42	15 28	631	610	+21	
6	15 58	16 54	615	602	+13	Absolute house, east pier.
Mean value of (C. I. W. − Christchurch).					+17.8γ or +0.00079H.	

[1]There is no appreciable station-difference.

TABLE 8 C.—*Results of Inclination Comparisons at the Christchurch Observatory, 1906–1908*
(Dip circles used by C. I W observers: Dover 171 for series I, and 169, 178, and 189 for series II)

Series	Date	Local mean time From	Local mean time To	C. I W. circle and needles	Inclination obtained[1] C. I W	Inclination obtained[1] Christ-church	C I W − Christ-church	Remarks
	1906	h m	h m		° ′	° ′	′	
I	July 10	9 16	10 24	171, 1 and 2	−67 48 0	−67 46 8	−1 2	No 171 at west pier, absolute house [2]
	10	11 24	12 26	171, 1 and 2	48 0	47 8	−0 2	
	10	14 46	15 49	171, 1 and 2	50 0	47 3	−2 7	
	11	9 42	11 16	171, 1 and 2	48 4	47 7	−0 7	No 171 at peg II[2], needles 5 and 6 arc of dip circle Dover 172
	11	14 45	15 50	171, 5 and 6	48 1	47 8	−0 3	
	12	10 10	11 20	171, 5 and 6	49 3	48 9	−0 4	
	12	14 24	15 22	171, 5 and 6	50 8	49 5	−1.3	
	16	11 43	12 42	171, 1 and 2	50 5	48 5	−2 0	
						Mean	−1 1	
	1907							
II	Dec. 30	15 33	16 25	178, 1 and 2	−67 50 7	−67 49 1	−1 6	No 178 at brass pipe.
	31	10 15	11 32	169, 1 and 2	52 9	51 8	−1 1	No. 169 near brass pipe.
	31	11 33	11 59	169, 1 and 2	52 2	51 4	−0 8	
	31	14 51	15 53	169, 1 and 2	51 1	48 8	−2 3	
	31	15 54	16 54	169, 1 and 2	50 8	48 8	−2 0	
	1908							
	Jan 3	11 41	13 04	189, 5 and 6	51 9	50 0	−1 9	No. 189 at brass pipe
	3	14 30	15 46	189, 5 and 6	50 8	48 2	−2 6	No. 189 at peg A
	3	15 54	17 01	189, 5 and 6	49 7	48 2	−1 5	
	3	17 31	17 58	178, 1 and 2	52 0	49 0	−3 0	No. 178 at peg A.
	6	12 23	12 48	178, 1 and 2	50 7	50 1	−0 6	No 178 at west pier, absolute house
						Mean	−1 7	
Weighted mean value of (C I W −Christchurch) from I and II .							−1 4	

[1]There is no appreciable station-difference between west pier absolute house and peg II, in series II, observations were made at 3 different points in the observatory inclosure and at west pier of absolute house, but there are no appreciable station-differences.

[2]Simultaneous observations by Mr. H. F Skey with Dover dip circle No 147 and needles 1, 2, and 3, station not designated but probably peg II for work on July 10, and west pier of absolute house for work on July 11, 12, and 16, 1906.

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(8) I. M. S.−Christchurch (Kew magnetometer No. 1)= +1′.1 (1906–08).

(8*a*) I. M. S.−Christchurch (Kew magnetometer No. 1)= +0.00064*H* (1907–08).

(8*b*) I. M. S.−Christchurch (Dover dip circle No. 147, needles 1, 2, 3)= −0′.9 (1906–08).

NO. 9.—DEHRA DUN OBSERVATORY, INDIA.

The comparisons at the Dehra Dun Observatory were secured at the conclusion of the magnetic expedition through China in 1909, which was under the leadership of Observer D. C. Sowers. Simultaneous observations were made at both the north (*N*) and south (*S*) absolute houses, the observers exchanging stations as shown in the tables below. The instruments used by the Observatory were: for declination and horizontal intensity, Kew-Elliott magnetometer No. 17, and for inclination, earth inductor No. 30; these instruments are the standards for the Magnetic Survey of India, Dehra Dun being the chief base-station of the Survey. The C. I. W. instruments used were: C. I. W. magnetometer No. 10 and Dover dip circle No. 171 (needles Nos. 5 and 6 of 172, and 7 of 178).

Some of the intensity results with magnetometer No. 17, not being entirely simultaneous with the C. I. W. observations, have been referred to the same instant of the latter by use of the magnetograph curves. The Observatory values are corrected fully for both distribution coefficients of the magnets; the value of the moment of inertia of the oscillation magnet and suspension being that determined in September 1909.[1]

[1]Upon the occasion of my visit to the Dehra Dun Observatory on September 29, 1911, Captain Thomas stated that he had under way a reexamination of the moment of inertia for magnetometer No. 17, and that this instrument, the Survey standard, gives lower values than the other instruments, with the exception of one; the average difference is about 27 gammas. —L. A B.

TABLE 9 A.—*Results of Declination Comparisons at the Dehra Dun Observatory, 1909.*

Date	Local mean time		Declination obtained[1]		C.I.W.—Dehra Dun	Station	
	From	To	C.I.W.	Dehra Dun		C.I.W.	D.D.
1909	h m	h m	° ′	° ′	′		
Oct. 20	16 15	16 22	+2 36.3	+2 36.5	−0.2	*S*	*N*
21	12 41	12 48	32.0	31.5	+0.5	*S*	*N*
21	15 57	16 06	35.2	35.0	+0.2	*N*	*S*
22	7 08	7 17	34.7	34.9	−0.2	*N*	*S*
22	11 07	11 14	34.9	35.0	−0.1	*N*	*S*
22	12 37	12 44	33.7	33.3	+0.4	*N*	*S*
Mean value of (C. I. W.—Dehra Dun)					+0.1		

[1]All values are referred to station *S*; $S = N + 0'.4$.

TABLE 9 B.—*Results of Horizontal-Intensity Comparisons at the Dehra Dun Observatory, 1909.*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Dehra Dun	Station	
	From	To	C.I.W.	Dehra Dun		C.I.W.	D.D.
1909	h m	h m	γ	γ	γ		
Oct. 20	14 52	16 02	33232	33183	+49	*S*	*N*
21	7 37	8 48	244	200	+44	*S*	*N*
21	11 21	12 35	297	233	+64	*S*	*N*
21	14 38	15 50	268	214	+54	*N*	*S*
22	7 21	8 48	258	202	+56	*N*	*S*
22	11 15	12 28	262	214	+48	*N*	*S*
23	10 57	12 07	228	172	+56	*S*	*N*
Mean value of (C. I. W.—Dehra Dun) . . .					+53.0γ or +0.00159*H*		

[1]There is apparently no appreciable difference between *S* and *N*.

TABLE 9 C.—*Results of Inclination Comparisons at the Dehra Dun Observatory, 1909.*

Date	Local mean time		Inclination obtained[1]		C.I.W.—Dehra Dun	Station	
	From	To	C.I.W.	Dehra Dun		C.I.W.	D.D.
1909	h m	h m	° ′	° ′	′		
Oct. 19	14 54	15 34	+43 58.5	+43 58.3	+0.2	*N*	*S*
19	15 42	16 14	59.2	58.0	+1.2	*N*	*S*
20	7 25	8 06	54.7	53.9	+0.8	*S*	*N*
20	8 16	8 56	51.3	53.9	−2.6	*S*	*N*
22	14 50	15 26	54.3	54.0	+0.3	*N*	*S*
23	7 19	7 58	53.2	53.4	−0.2	*S*	*N*
23	7 59	8 45	53.2	53.8	−0.6	*S*	*N*
Mean value of (C. I. W.—Dehra Dun).					−0.1		

[1]The station-difference appears to be negligible.

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(9) I. M. S.—Dehra Dun (Elliott magnetometer No. 17) = 0′.0 (1909).

(9*a*) I. M. S.—Dehra Dun (Elliott magnetometer No. 17) = +0.00144*H* (1909).

(9*b*) I. M. S.—Dehra Dun (Earth inductor No. 30) = +0′.4 (1909).

NO. 10.—FALMOUTH OBSERVATORY, ENGLAND.

The comparisons at the Falmouth Observatory were obtained at the time of the visit of the *Carnegie* to Falmouth in October 1909. The station occupied was the brick pier in the small hut used by the Observatory for the absolute observations. The mark for the declination observations was the same one used by the Observatory and is a stone set up on the hillside opposite; its azimuth, as determined by the Observatory is 4° 40′.7 W. of S. At certain times the bisecting of the stone must be made with some uncertainty, which fact may account for the range in the tabulated declination-differences, C. I. W.−Falmouth.

It was not possible at the time for Superintendent E. Kitto to observe simultaneously with the *Carnegie* observer, Mr. E. Kidson. Accordingly the "Falmouth" values are those derived from the magnetograph as based on Mr. Kitto's absolute observations made on October 6, 25 and 30, and Mr. Baker's on October 14, 1909; they are the final values as supplied in June 1913. Mr. Kidson observed with C. I. W. magnetometers Nos. 2 and 4, and with Dover dip circle No. 201 (needles Nos. 1 and 2). The Observatory instruments were: Elliott magnetometer No. 66 and dip circle No. 86, needles 1 and 2.

TABLE 10 A.—*Results of Comparisons at the Falmouth Observatory, 1909.*

Date	Local mean time		Value obtained		C. I. W −Falmouth	Weight	Remarks
	From	To	C. I. W.	Falmouth			
			Declination				
1909	h m	h m	° ′	° ′	′		
Oct. 22	10 07	10 16	−17 46 1	−17 46 4	+0 3	1.0	C. I W. magnetometer 2 used.
22	12 12	12 21	50.1	49 7	−0 4	1 0	
22	13 31	13 40	49.8	50 6	+0 8	1 0	
23	10 02	10 11	52.2	51 5	−0 7	1.0	C. I W magnetometer 4 used
23	11 48	11 57	52.5	51 7	−0 8	1 0	
23	13 07	13 16	57 7[1]	56 0[1]	−1 7[1]	0 5	
29	11 01	11 10	47 7	49 4	+1 7	1 0	
29	14 24	14 33	50.9	51 5	+0 6	1 0	
Weighted mean value of (C. I. W.−Falmouth) .					+0 1		
			Horizontal Intensity				
			γ	γ	γ		
Oct. 22	10 24	11 11	18741	18757	−16	1.0	C. I. W. magnetometer 2 used.
22	11 19	12 03	758	759	− 1	1 0	
22	13 58	14 41	758	766	− 8	1.0	
22	14 52	15 33	776	768	+ 8	1 0	
23	10 16	10 55	734	746	−12	1 0	C. I W. magnetometer 4 used
23	11 03	11 39	707[1]	736[1]	−29[1]	0 5	
29	11 27	12 11	768	768	0	1 0	
29	13 20	14 03	762	766	− 4	1 0	
Weighted mean value of (C. I. W.−Falmouth) .					− 6 3γ or −0 00034*H*.		
			Inclination				
			° ′	° ′	′		
Oct 22	16 10	16 46	+66 31.1	+66 33 3	−2 2	1 0	
23	8 46	9 22	32 5	34 6	−2 1	1 0	
23	12 13	12 42	35 9[1]	37 7[1]	−1 8[1]	0 5	
29	9 51	10 25	30 4	31 0	−0 6	1 0	
29	16 04	16 36	31.3	31 4	−0 1	1 0	
Weighted mean value of (C. I. W.−Falmouth) .					−1.3		

[1]A slight magnetic disturbance occurred at the time of these observations

TABLE 10 B.—*Results of Comparisons between the Observatory Standards at Falmouth and Kew, 1891 to 1909.*

No	Observatories compared, and date	Declination	Horizontal Intensity	Inclination
		′	γ	′
1	C. I. W.−Falmouth, Oct. 1909 . . .	+0 1	− 6 3 or −0 00034*H*	−1 3
2	C. I. W −Kew, Mar. 1908 and Mar. 1910	+0 7	+ 1 3 or +0 00007*H*	−1.7
3	Kew−Falmouth, from Nos. 1 and 2, 1909	−0 6	− 7 6 or −0 00041*H*	+0 4
4	Kew−Falmouth, Rucker, 1895 . .	+0 8	−24 or −0 00131*H*	−1.6
5	Kew−Falmouth, R. and T., Survey, 1891	−0 1	−11 or −0 00060*H*	−0.9

The data for No. 2 are those published on pp. 241–242 of this volume; those for No. 3 are derived by combination of Nos. 1 and 2 and those for No. 4 are the results of Rücker's comparisons in 1895.[1] Comparing Nos. 3 and 4 it will be seen that the 1909 Falmouth corrections on Kew are for each element numerically smaller than in 1895. There have been no direct comparisons between Kew and Falmouth since those of Rücker, hence it can not be determined, in the absence of other information, when the large improvement in the H-correction occurred and to what it may be due. Mr. L. F. Richardson, the present superintendent of Eskdalemuir Observatory, made comparisons at Falmouth the end of June and early in July 1913, but the results are not at present available.

The data for No. 5 are derived as follows:

TABLE 10 C —*Magnetic elements at the Falmouth Observatory for January 1, 1891.*

No.	Date	Declination	Inclination	Horizontal Intensity	Remarks
		° ′	° ′	γ	
a	1890 5	−19 24 2	+67 08 5	18420	Mean of absolute observations during 1890
b	1891 5	−19 18 3	+67 08 1	18429	Mean of tabulated hourly values during 1891, except that dip value is again mean of all absolute observations.
c	1891 0	−19 21 2	+67 08 3	18424	Mean of Nos *a* and *b*
d	1891 0	−19 20 9	+67 08 6	18422	Deduced from No *a*, by applying secular changes 1890 5 to 1891 0 as derived from 1891 5 and 1892 5 values.
e	1891 0	−19 21 1	+67 08 4	18423	Mean of Nos *c* and *d*, adopted for Falmouth Observatory observations
f	1891.0	−19 18 7	+67 07 5	18441	Rucker and Thorpe's M S, 1896 Memoir, Table XXIV
		−2 5	0 0	−29	Corrections of Rücker and Thorpe's standards on Kew (see 1896 Memoir, pp. 15, 21, 27)[1]
g	1891 0	−19 21 2	+67 07 5	18412	Rücker and Thorpe's values reduced to Kew standards.
h	1891 0	−0 1	−0 9	−11	Hence Falmouth corrections on Kew standards (*g*—*e*)

[1]The published correction for H, -23γ, has been algebraically decreased by 6γ, since it appears that the values of H with the Kew magnetometer, prior to 1908, require to be decreased by this amount on account of various accumulated errors. (Dr. Chree's letter to L A. Bauer, June 3, 1910.)

Assembling the chief results and referring them to I. M. S. (see p. 273), we obtain:

(10) I. M. S. – Falmouth (Elliott magnetometer No. 66) = 0′.0 (1909).
(10*a*) I. M. S. – Falmouth (Elliott magnetometer No. 66) = − 0.00049H (1909).
(10*b*) I. M. S. – Falmouth (Dip circle No. 86, needles 1 and 2) = − 0′.8 (1909).

NO. 11.—HAVANA OBSERVATORY, CUBA.

In the intercomparisons of magnetic instruments at Havana, May 19–23, 1905, two stations were used, viz: C, the absolute observing-house of the Observatorio del Colegio de Belén; V, the United States Coast and Geodetic Survey Station of 1903 at the villa Asunción de los Jesuitas, located about 3 kilometers south of C.

The observations were, in general, simultaneous, and the observers exchanged stations during the series. The instruments used by the C. I. W. observer were: U. S. C. and G. S. magnetometer No. 19 and Dover dip circle No. 171. Unfortunately, the Observatory instruments were not at the time in best condition and the constants for the magnetometer (Kew No. 51) had not been recently redetermined; the dip circle had only one needle (No. 1). Accordingly, only the mean results, referred to I. M. S. (see p. 273), are given:

I. M. S.—Havana (May 1905).
Declination, 11 sets. . . . . +0′.8.
Horizontal Intensity, 5 sets. . . . . . −0.00965H.
Inclination, 6 sets. . . . . . . +2′.1.

The approximate values of the station-difference ($C-V$) were as follows at the time: −1′.8 (for declination), −0′.9 (for inclination) and -19γ (for horizontal intensity).

[1]Report Brit. Assoc Adv. Sc. 1896; a correction of -6γ was applied to the Kew values according to information supplied by Dr. Chree, June 3, 1910.

NO. 12.—HELWAN OBSERVATORY, NEAR CAIRO, EGYPT.

Three series of comparisons have been obtained at the Helwan Observatory in the course of the field work of the Department of Terrestrial Magnetism, viz:

Series I by Observer J. C. Pearson, April 21–28, 1908, using C. I. W. magnetometer No. 5 and Dover dip circle No. 177 (needles 1, 2, 5, and 6).
Series II by Observer W. H. Sligh, May 17–24, 1911, using C. I. W. magnetometer No. 7 and Dover dip circle No. 202 (needles 1, 2, 5, and 6).
Series III by Observer W. F. Wallis, March 12–14, 1914, using C. I. W. magnetometer No. 10 and Dover dip circle No. 202 (needles 1, 2, 5, and 7).

The Observatory instruments were Kew-pattern magnetometer Elliott No. 87 and Dover dip circle No. 193 (presumably needles 1 and 2). Throughout, the method of comparison by simultaneous observations was employed, the observers exchanging stations in order to eliminate the station-differences. For the Observatory the observations were made in 1908 and 1911 by Mr. Hurst, and in 1914, by Mr. Eckersly.

The results from Series I were published in detail in "Terrestrial Magnetism," vol. 16, pp. 145–146. The mean revised results are:

C. I. W.−Helwan (1908).

Declination . . . . $+0'.5$ (13 sets).
Horizontal Intensity . . . . . . $+10.0\gamma$ (?) or $+0.00033H$ (?) (6 sets).
Inclination . . . . $+0'.6$ (5 sets).

The horizontal-intensity difference is marked doubtful, for it will be noticed that it differs materially from those obtained in 1911 and 1914. Mr. Hurst compared the Helwan magnetometer No. 87 at Kew in October 1907, finding that No. 87 was in practical agreement with the Kew standard. However, since the publication[1] of the observations, Dr. Chree has found it necessary to decrease the Kew values by 6.3γ on account of various accumulated errors in the constants of the Kew standard.[2] Hence we have, for October 1907, (Kew−Helwan) = $-6.3\gamma = -0.00034H$.

Mr. Pearson, using the same instruments at Kew as at Helwan, found in March 1908 that (C. I. W.−Kew) was equal to $+0.000065H$, and in March 1910 equal to $+0.000075H$ (see Table 14 B, p. 241); hence the mean value of (C. I. W.−Kew) was $+0.00007H$. Combining the results of Messrs. Hurst and Pearson we get, indirectly, (C. I. W.−Helwan) = $-0.00027H$, which tends to confirm the directly-observed results at Helwan in 1911 and 1914. The question therefore arises whether there may not possibly be an error in the 1908 result.

The value of log π^2K at 0° C. for magnet $87A$, as determined at Kew (by the Observatory and by Mr. Hurst) in October 1907, was 3.45319; the value as determined by Mr. Hurst at Helwan in December 1907 was 3.45272, the change being ascribed by Mr. Hurst to "a slight shift of the magnet in its stirrup" during transportation between Kew and Helwan.[1] The 1908 H-values at Helwan, as supplied by the Observatory, were computed with the later value of log π^2K; had they been computed with the Kew value of this constant, they would have been higher by $0.00054H$, and the resulting value of (C. I. W.−Helwan) would have been $-0.00021H$, thus agreeing well with that deduced above by a combination of the respective comparisons at Kew of Messrs. Hurst and Pearson, and also corresponding, in general, with the results from the comparisons of 1911 and 1914.

Looking over the publications of the Observatory it would appear, from various statements and from the annual values of H, that more or less difficulty has been encountered

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[1]Standardization of the Magnetic Instruments at Helwan Observatory during 1907; Survey Department paper, No. 8, Cairo, 1908.
[2]*Terr. Mag.*, vol. 16, 1911, p. 72.

with respect to the constancy of magnetometer No. 87. It is also the practice to use new values from time to time of the distribution coefficients P and Q, as derived from observations over a limited period.

The observations for series II and III were made in the "absolute room," or "porch," in the west end of the magnetic observatory,[1] and in a small wooden hut about 20 meters southwest of the Observatory. The stone pier in the small wooden hut is designated as "hut," the north pier in the absolute room as N (for D and H observations), and the south pier in the absolute room as S (for I observations).

There may have been some confusion in the precise marks observed upon during the declination series, No. III, or possibly some source of disturbance was present; it will be noticed that both the declination-difference (C. I. W.—Helwan) and the station-difference have changed appreciably since 1911. Hence it is deemed best to mark the 1914 declination-result in the final summary as doubtful.

TABLE 12 A.—*Results of Declination Comparisons at the Helwan Observatory (Series II).*

Date	Local mean time		Declination obtained[1]		C. I. W.—Helwan	Remarks
	From	To	C. I. W.	Helwan		
1911	h m	h m	° ′	° ′	′	
May 17	10 09	10 18	−2 33 9	−2 33.7	−0 2	C. I. W. magnetometer at "hut;" Helwan magnetometer at N.
17	12 24	12 33	38 3	37.4	−0 9	
18	8 40	8 49	31 7	31.8	+0 1	
18	12 14	12 23	35 4	36.3	+0.9	
18	12 36	12 45	35 0	37.3	+2 3	
18	14 43	14 52	35.7	36.2	+0 5	
23	9 14	9 23	32.7	33 1	+0.4	C. I. W. magnetometer at N; Helwan magnetometer at "hut."
23	11 24	11 33	35.2	36 4	+1 2	
24	8 52	9 01	31.9	30.7	−1.2	
24	9 12	9 21	32 0	32.7	+0 7	
24	9 26	9 35	32.2	33.1	+0.9	
24	10 06	10 15	33.3	33.5	+0 2	
24	12 28	12 37	35 2	35.5	+0.3	
Mean value of (C. I. W.—Helwan, 1911)........					+0.4	

[1]All values are referred to N; N="hut"+0′.5.

TABLE 12 B.—*Results of Horizontal-Intensity Comparisons at the Helwan Observatory (Series II).*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Helwan	Remarks
	From	To	C. I. W.	Helwan		
1911	h m	h m	γ	γ	γ	
May 17	10 28	12 18	30020	30042	−22	C. I. W. magnetometer at "hut," Helwan magnetometer at N.
18	8 54	10 29	010	010	00	
18	15 02	16 32	012	034	−22	
23	9 27	10 54	042	059	−17	C. I. W. magnetometer at N; Helwan magnetometer at "hut"
23	12 06	13 25	048	047	+ 1	
24	10 20	12 04	051	080	−29	
Mean value of (C. I. W.—Helwan, 1911)					−14.8γ or − 0.00049H.	

[1]All values are referred to N; N="hut"−7γ.

[1]It appears that in 1908, when Mr. Pearson made his observations, the "absolute room" was the room in the *east* end of the magnetic observatory.

TABLE 12C.—*Results of Inclination Comparisons at the Helwan Observatory (Series II).*

Date	Local mean time		Needles D.C.202	Inclination obtained[1]		C.I.W.—Helwan	Remarks
	From	To		C. I. W.	Helwan		
1911	h m	h m		° ′	° ′	′	
May 20	9 56	11 50	1, 2	+40 39 9	+40 39 3	+0 6	
20	10 22	11 26	5, 6	40 9	40.0	+0 9	
20	12 04	12 58	1, 2	39 2	38 7	+0 5	C. I. W. at "hut," Helwan D. C. at *S*.
21	9 34	11 06	1, 2	40 6	39 4	+1 2	
21	9 56	10 42	5, 6	39 8	39 6	+0 2	
21	11 46	13 24	1, 2	42 8	42 0	+0 8	
22	8 40	10 12	1, 2	42 8	42.4	+0 4	C. I. W. at *S*, Helwan D. C. at "hut."
22	9 04	9 50	5, 6	43 2	42 4	+0 8	
22	10 16	12 12	1, 2	42 8	42.2	+0 6	
Mean value of (C. I. W.—Helwan, 1911)						+0 7	

[1]All values are referred to *S*; *S*="hut"+0′.4.

TABLE 12D.—*Results of Declination Comparisons at the Helwan Observatory (Series III).*

Date	Local mean time		Declination obtained[1]		C I.W.—Helwan	Remarks
	From	To	C. I. W.	Helwan		
1914	h m	h m	° ′	° ′	′	
Mar. 12	9 22	9 31	−2 08 7	−2 11 7	+3 0	
12	12 00	12 09	12 3	13.9	+1 6	C I. W. magnetometer at "hut;" Helwan magnetometer at *N*.
12	12 33	12 42	12 7	16 1	+3 4	
13	9 11	9 20	08 1	09 6	+1 5	
13	11 18	11 27	11 0	11 7	+0 7	
13	15 19	15 28	10 3	11 7	+1 4	
13	17 19	17 28	09 9	11 8	+1 9	C. I W. magnetometer at *N*; Helwan magnetometer at "hut."
14	8 52	9 01	09 2	11.6	+2 4	
14	10 54	11 03	10 4	13.6	+3 2	
14	16 27	16 36	10 2	11 8	+1 6	
Mean value of (C. I. W.—Helwan, 1914) ...					+2 1	

[1]All values are referred to *N*; *N*="hut"+1′.4.

TABLE 12E.—*Results of Horizontal-Intensity Comparisons at the Helwan Observatory (Series III).*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Helwan	Remarks
	From	To	C. I. W.	Helwan		
1914	h m	h m	γ	γ	γ	
Mar. 12	9 54	11 40	30001	30009	− 8	C. I. W. magnetometer at "hut;" Helwan magnetometer at *N*.
13	9 29	11 00	016	028	−12	
13	15 39	17 00	016	020	− 4	C. I. W. magnetometer at *N*; Helwan magnetometer at "hut."
14	9 11	10 40	036	052	−16	
Mean value of (C. I. W.—Helwan, 1914) .					−10.0 γ or −0 00033*H*.	

[1]All values are referred to *N*; *N*="hut"−8γ.

TABLE 12 F—*Results of Inclination Comparisons at the Helwan Observatory (Series III)*

Date	Local mean time		Needles D C 202	Inclination obtained[1]		C.I W.—Helwan	Remarks
	From	To		C I W.	Helwan		
1914	h m	h m		° ′	° ′	′	
Mar. 12	15 16	16 41	1, 2, 5, 7	+40 50 8	+40 50 5	+0.3	C.I W. at "hut;" Helwan D C at S
13	11 51	13 17	1, 2, 5, 7	48.5	47 8	+0 7	C.I W. at "hut;" Helwan D C at S
14	11 36	12 59	1, 2, 5, 7	48 1	47 6	+0 5	C.I.W at S, Helwan D.C at "hut"
14	14 47	16 09	1, 2, 5, 7	51 1	50 8	+0 3	C.I.W at S, Helwan D.C at "hut"
Mean value of (C I. W.—Helwan, 1914)						+0 4	

[1]All values are referred to S. S= "hut"+0′ 0.

TABLE 12 G—*Summary of Values of (C. I. W.—Helwan) for 1908–1914.*

Series	Date	Declination	Hor. intensity	Inclination
I	1908, Apr. 21–28	+0′ 5	.	+0′ 6
II	1911, May 17–24	+0 4	−0.00049H	+0 7
III	1914, Mar. 12–14	+2 1(?)	−0 00033H	+0 .4
Mean	1908–1914	+0 4	−0 00041H	+0 6

Referring the results to I. M. S. (see p. 273), we obtain:

(12) I. M. S.—Helwan (Elliott magnetometer No. 87) = +0′.3 (1908–11).

(12*a*) I. M. S.—Helwan (Elliott magnetometer No. 87) = −0.00056H (1911–14).

(12*b*) I. M. S.—Helwan (Dover dip circle No. 193) = +1′.1 (1908–14).

NO. 13—HONGKONG OBSERVATORY, CHINA.

The comparisons for declination and horizontal intensity at the Hongkong Observatory were made in the observing house and at an outside or tent station (B) distant 14.33 meters from the south pier in the observing house and in true bearing south 2° 08′.7 east of this pier. The Observatory instruments used were: Elliott magnetometer No. 55 and Dover dip circle No. 71 (needles 3, 4, 7, and 8). The north pier (A) of the observing house is 2.55 meters from the south pier (A'); A is used for the magnetometer and A' for the dip circle.

The 1908 D and H comparisons were obtained by simultaneous observations by the Observatory with No. 55 and the C. I. W. observer (D. C. Sowers) with C. I. W. magnetometer No. 10. Those of 1907 and 1911 were all made by Observer C. K. Edmunds, observing with both magnetometers alternately so that the mean time of the observations with the C. I. W. magnetometer (No. 2 in 1907 and No. 12 in 1911) would be practically the same as for the Observatory instrument, No. 55. It should be remarked that the Observatory also has a magnetometer No. 83, of the same pattern as No. 55 and purchased in 1897, but, so far as known, no use of this newer instrument has been made other than for some observations in 1898 from which it was found that at that time No. 55 required an H-correction on No. 83 of $+52\gamma = +0\ 00141H$.

The dip comparisons of December 1908 were not satisfactory. New comparisons were, therefore, made at the first opportunity during March 1 to 6, 1911; the two stations, A' and B, were occupied. The observations were made by Observer C. K. Edmunds, alternately with the two instruments set up at the two stations. The observations were made with two needles of one instrument at station A', then with four needles of the other instrument at station B, and finally with the remaining two needles of the first instrument

at station A', thus making the mean times for each instrument at each intercomparison practically the same. The C. I. W. dip circle used was Dover No. 206 (with its own needles 1 and 2, and 5 and 6 of dip circle No. 178).

TABLE 13 A.—*Results of Declination Comparisons at the Hongkong Observatory, 1908 and 1911.*

Date	Local mean time		Declination obtained[1]		C.I.W.—Hongkong	Remarks
	From	To	C I W.	Hongkong		
1908	h m	h m	° ′	° ′	′	
Dec 21	10 03	10 12	+0 06 7	+0 06 7	0 0	Magnetometer No 10 at B, No 55 at A.
23	9 12	9 21	+0 06 8	+0 04 9	+1 9	
23	15 49	15 58	+0 06 5	+0 06 3	+0 2	Magnetometer No 10 at A, No. 55 at B.
1911						
June 29	15 38	16 00	−0 01 6	−0 03 2	+1 6	Magnetometer No. 12 at B, No 55 at A.
29	17 19	17 39	−0 00 6	−0 02 4	+1 8	
30	16 11	16 31	−0 00 8	−0 01 2	+0 4	
July 1	13 44	14 00	−0 01 4	−0 01 8	+0 4	
6	10 59	11 16	−0 00 8	−0 04 3	+3 5	Magnetometer No 12 at A, No. 55 at B
6	12 57	13 12	−0 01 4	−0 04 2	+2 8	
6	14 09	14 25	−0 01 5	−0 03 6	+2 1	
7	9 20	9 39	+0 01 6	+0 00 3	+1.3	Magnetometer No 12 at B, No. 55 at A.
7	15 20	15 37	0 00 0	−0 01 7	+1 7	
7	16 46	16 59	−0 00 2	−0 01.8	+1 6	
18	10 55	11 11	−0 01 2	−0 01 5	+0 3	Magnetometer No 12 at A, No 55 at B.
19	8 10	8 32	+0 01 7	+0 00.5	+1 2	
19	15 10	15 25	−0 00.6	−0 01 3	+0.7	
19	15 56	16 12	−0 00 7	−0 01.3	+0 6	Magnetometers Nos. 12 and 55 used alternately at A.
20	11 46	12 03	−0 01.8	−0 02 8	+1 0	
20	16 04	16 21	−0 01 4	−0 02.0	+0 6	
20	17 28	17 42	−0 01 4	−0 02.4	+1 0	Magnetometer No 12 at B; No. 55 at A
21	7 15	7 24	+0 01 3	−0 00 1	+1 4	
21	8 30	8 42	+0 01 6	+0 00.3	+1 3	
Mean value of (C. I. W.—Hongkong)					+1 2	

[1]All values are referred to station A, $A=B+2'.6$.

TABLE 13 B —*Results of Horizontal-Intensity Comparisons at the Hongkong Observatory, 1907-1911.*

Series	Date	C.I.W.—Hongkong (No. 55)	Remarks
I	1907, Aug. 14-15	+0 0009H	2½ sets, weight, 1 0
II	1908, Dec. 21-24	+0 0022H	4 sets; weight, 1 0.
III	1911, June 30-July 19	+0 0012H	13 sets; weight, 3 0.
Weighted mean .		+0 00134H	

It will be noted that the result from series II differs considerably from those for series I and III, which are in fair accord. It has not been possible to determine whether the H-values with the Observatory instrument (No. 55) depend upon strictly comparable constants, somewhat different constants being used from time to time.

The large value of the correction of No. 55 as found above, viz, +0 00134H, is believed to be chiefly due to the fact that in the Observatory computations the deflection distances 30 and 40 cm. are assumed as absolutely correct at 0° C. Curiously enough, the correction of No. 55, as found from the C. I. W. comparisons, is practically the same as that above cited (+0 00141H), which resulted from the comparisons in 1898 between Nos. 55 and 83, the constants of the latter instrument having been determined in 1897 at Kew. No. 55 was purchased in 1883 and has been in use at the Observatory since about 1884.

TABLE 13 C.—*Results of Inclination Comparisons at the Hongkong Observatory, 1911.*

Date	Local mean time		Inclination obtained[1]		C I W.—Hongkong	Remarks
	From	To	C I.W.	Hongkong		
1911	h m	h m	° ′	° ′	′	
Mar 1	10 03	14 55	+30 57.6	+30 58 2	−0 6	D C No. 206 at B, No 71 at A'
2	8 40	12 21	57.6	58 8	−1 2	
2	13 18	16 41	57 5	57 8	−0 3	
3	10 12	14 21	56 1	56 2	−0.1	D C No 206 at A'; No 71 at B
4	7 58	11 28	56 8	57 0	−0.2	
4	12 28	17 23	56 9	57 0	−0.1	
5	10 12	14 41	56 4	55 4	+1 0	D C No. 206 at B; No. 71 at A'.
6	10 24	14 46	56 2	57 1	−0 9	D. C. No 206 at A'; No. 71 at B.
Mean value of (C I W —Hongkong)					−0 3	

[1]All values referred to station A'; $A'=B-0'.6$.

Referring the mean results to I. M. S. (see p. 273), we obtain:

(13) I. M. S.—Hongkong (Elliott magnetometer No. 55) = +1'.1 (1908–11).

(13*a*) I. M. S.—Hongkong (Elliott magnetometer No. 55) = +0.00119H (1907–11).

(13*b*) I. M. S.—Hongkong (Dover dip circle No. 71, needles 3, 4, 7, 8) = +0'.2 (1911).

NO 14—KEW OBSERVATORY, ENGLAND.

In the comparisons at the Kew Observatory, the C. I. W. observations by Mr. J. C. Pearson were made on the middle pier of the new absolute house; on several days observations simultaneous with Mr. Pearson's were made by Mr. Baker, of the Observatory, in the old absolute building, about 25 yards north of the station occupied by Mr. Pearson. Observing stations were not exchanged, as Dr. Chree, the Superintendent of the Observatory, stated that no appreciable differences in the magnetic elements existed between the two points. Consequently the various comparisons are based on the magnetograms, these having been standardized by the observations with the Jones unifilar magnetometer and the Barrow dip circle of the Observatory.

The Kew results as given here have been corrected by Dr. Chree for the following sources of error: (*a*) that arising from assuming the quantity$(1+P'r^{-2})=(1+Pr^{-2}+Qr^{-4})$, *i. e.*, assuming that Q is negligible; (*b*) that arising from neglecting to take into account the bending of the deflection bar; (*c*) that arising from error in the accepted value of the moment of inertia.

The instruments used by Mr. Pearson were: C. I. W. magnetometer No. 5 and Dover dip circle No. 177 (needles 1, 2, 5, and 6). In the interval between the two series of comparisons, 1908–1910, Mr. Pearson carried out a strenuous campaign of field work in the Turkish Empire, Persia, Asiatic Russia, and Egypt, the same instrumental constants being used throughout.

TABLE 14 A.—*Results of Declination Comparisons at the Kew Observatory, 1908–1910.*

Series	Date	Local mean time		Declination obtained		C.I.W.—Kew	Remarks
		From	To	C.I.W.	Kew		
	1908	h m	h m	° ′	° ′	′	
I	Mar. 10	12 20	12 29	−16 22 4	−16 22 7	+0 3	Before extensive field work with C. I. W. magnetometer No. 5
	10	15 15	15 24	21 8	22 9	+1 1	
	10	15 37	15 46	21 5	22 6	+1 1	
	10	15 50	15 59	20.8	22 2	+1 4	
	11	9 04	9 10	17.0	18 9	+1 9	
	11	10 52	10 58	19 6	20 2	+0 6	
	11	12 36	12 43	24.4	24.3	−0 1	
	11	13 00	13 07	25 5	25.5	0.0	
	11	14 19	14 26	23.9	23.5	−0.4	
	12	14 38	14 44	21.4	21.2	−0 2	
	12	16 28	16 34	19.2	19 1	−0 1	
	13	9 14	9 20	14.8	16 7	+1 9	
	13	10 58	11 05	18.2	19 8	+1 6	
	17	13 08	13 14	27.7	27 1	−0 6	
	17	14 26	14 35	24.9	24 9	0 0	
Mean..						+0 57	
	1910						
II	Mar. 8	9 32	9 41	−16 03 2	−16 04 7	+1 5	After extensive field work with C. I. W magnetometer No. 5
	8	11 37	11 46	08 6	09 5	+0 9	
	8	12 01	12 10	09 3	09.9	+0 6	
	8	14 23	14 32	09.3	10 2	+0 9	
	8	14 43	14 52	08.8	09 7	+0 9	
	8	16 35	16 44	06 7	07.9	+1 2	
	9	9 13	9 22	05.1	05 7	+0 6	
	9	11 01	11 12	09 4	09 8	+0 4	
	9	12 45	12 54	10 2	10 9	+0 7	
	9	14 12	14 21	09.6	10.5	+0 9	
	9	14 22	14 31	09 6	10 3	+0 7	
	11	11 14	11 23	10.2	10 7	+0 5	
	11	14 08	14 17	11 2	11 7	+0 5	
	11	14 18	14 27	10.7	11 1	+0.4	
Mean						+0 76	
Mean value of (C. I. W.—Kew) from I and II						+0 7	

TABLE 14 B —*Results of Horizontal-Intensity Comparisons at the Kew Observatory, 1908–1910.*

Series	Date	Local mean time		Hor. int obtained		C.I W.—Kew	Remarks
		From	To	C I W.	Kew		
	1908	h m	h m	γ	γ	γ	
I	Mar 10	12 36	15 12	18504	18503	+1	Before extensive field work with C. I. W. magnetometer No. 5.
	11	9 14	10 49	499	495	+4	
	11	11 03	12 29	498	498	0	
	12	14 47	16 24	506	503	+3	
	13	9 22	10 56	491	490	+1	
	17	11 30	13 02	495	497	−2	
Mean						+1.2	
	1910						
II	Mar. 8	9 50	11 33	18494	18496	−2	After extensive field work with C. I. W. magnetometer No. 5.
	8	12 17	14 20	505	502	+3	
	8	14 56	16 31	506	503	+3	
	9	9 26	10 59	499	500	−1	
	9	11 22	12 43	512	513	−1	
	11	11 28	13 04	502	500	+2	
	12	11 27	12 09	512	502	+10[1]	
Mean						+1.4	
Mean value of (C. I. W.—Kew) from I and II...						+1 3 γ or +0 00007*H*.	

[1]Half set; weight, 0.5

TABLE 14 C.—*Results of Inclination Comparisons at the Kew Observatory, 1908–1910.*

Series	Date	Local mean time		D. C. 177 Needles	Inclination obtained		C.I.W.—Kew	Remarks
		From	To		C.I.W.	Kew		
	1908	h m	h m		° ′	° ′	′	
I	Mar. 9	15 19	17 00	1, 2, 5, 6	+66 59 5	+67 01 8	−2 3	Before extensive field work with D. C. No 177
	11	15 03	17 53	1, 2, 5, 6	58 4	01 6	−3 2	
	12	9 06	12 33	1, 2, 5, 6	59 2	02 2	−3 0	
	17	9 32	10 47	1, 2	60 3	02 3	−2 0[1]	
	17	14 52	16 07	1, 2, 5, 6	59 2	01 7	−2 5	
Mean							−2.7	
	1910							
II	Mar. 9	15 15	16 44	1, 2, 5, 6	+66 58 1	+66 58 3	−0 2	After extensive field work with D. C. No 177.
	10	9 23	10 37	1, 2, 5, 6	57 9	58 3	−0 4	
	10	11 20	12 28	1, 2, 5, 6	57 8	58 3	−0 5	
	11	9 22	10 38	1, 2, 5, 6	58 0	58 8	−0 8	
	11	14 58	16 24	1, 2, 5, 6	56 7	58 4	−1 7	
	12	9 22	10 53	1, 2, 5, 6	58.3	59 8	−1 5	
Mean							−0 8	
Mean value of (C. I. W.—Kew) from I and II							−1.7	

[1]Half set, weight, 0 5.

As the great majority of dip circles are made in England and are tested at the Kew Observatory before purchase, and provided, when found satisfactory, with Kew certificates giving the results of the comparisons, it will be a matter of interest, as well as of importance, to determine, if possible, the absolute correctness of the Kew Inclination Standard (Barrow dip circle No. 33, needles 1 and 2). The result from Table 14C would give $-1'.2$ for the correction of the Kew standard on I. M. S. (see p. 273), *i. e.*, the Kew instrument yields values of dip apparently about 1′ too high. As the results from series I and II are not in satisfactory accord, it will be desirable to secure further evidence.

In Table 14D are given in the column "Circle—Kew," the differences obtained by the Kew Observatory for 10 new Dover dip circles purchased by the Carnegie Institution of Washington (Department of Terrestrial Magnetism) during the period 1904–11; the quantities are taken directly from the Kew certificates. These same circles were compared, as soon as possible, at Washington, where the inclination is only about 3° greater than at Kew. In the column "I. M. S.—Circle" are given the results of the Washington comparisons as referred to I. M. S., chiefly by means of the Schulze earth inductor No. 48 (see p. 273). From the combined comparisons of the 10 dip circles at Kew and Washington, are obtained the results in the last column. From this table we accordingly find that the mean value of the difference (I. M. S.—Kew) = $-1'.17$.

TABLE 14 D.—*Results of Indirect Inclination Comparisons between Kew Standard and I. M. S.*

No.	Dover D. C.	Needles	Date of Kew Certificate	Circle—Kew	Date of Washington Comparisons	I. M. S.—Circle	I.M.S.—Kew
				′		′	′
1	171	1, 2	1904, Nov	−2 0	1905–06	+1.0	−1 0
2	172	1, 2	1905, Apr.	−2 0	1907	−0 4	−2 4
3	177	1, 2	1905, Nov	−1.9	1907	−0 2	−2 1
4	178	1, 2	1905, Nov.	−1 5	1906	−1 0	−2 5
5	201	1, 2, 5, 6	1909, Jan.	−1 0	1909–10	+0 3	−0 7
6	202	1, 2, 5, 6	1909, Jan.	−0.8	1909, Apr., May	+0 9	+0 1
7	205	1, 2, 5, 6	1909, June	−1 2	1910, Apr.	0 0	−1 2
8	206	1, 2	1909, Aug.	−1 5	1910, July, Sept	−0 2	−1 7
9	222	1, 2, 5, 6	1911, Oct	−0 2	1913–14	+0 2	0 0
10	223	1, 2, 5, 6	1911, Nov.	−0 2	1912–14	0 0	−0 2
Mean				−1 23	Means	+0 06	−1 17

Our next check on the possible correction of the Kew Barrow dip circle No. 33 on an international standard is afforded by Table 14E, which gives the results of comparisons of 16 new dip circles with the Kew standard between 1902–15. The results for these 16 dip circles are taken directly from the Kew certificates furnished with the instruments and are, accordingly, those obtained by the Kew Observatory itself. It is the custom of the Observatory to give the result of its test for each needle of a dip circle only to the nearest 0′.5; where quantities appear in the table to the nearest 0′.1, they have been furnished by the Observatory at our own request, though they are not vouched for to that accuracy. Glancing over the last column, it will be seen that 4 of the instruments were those purchased in recent years by the United States Coast and Geodetic Survey, and 12 of them by the Carnegie Institution of Washington (Department of Terrestrial Magnetism).

TABLE 14E —*Comparısons of 16 Dip Circles at Kew, 1902-15, with Barrow Dıp Cırcle 33*

Serial No.	Maker's No[1]	Date.	(Circle−Kew) for Needle No — 1	2	3	4	5	6	7	8	Circle−Kew Mean	Owner
			′	′	′	′	′	′	′	′	′	
1	C18[1]	1902, Jan	−1 8	−1 7	−1 1	−0 4					−1 2	C &G S
2	171	1904, Nov	−1 9	−2 2	−2 7	−2 2					−2 2	C. I W.
3	172	1905, Apr.	−2 2	−1 7	−1 9	−1 8	−1 2	−1 2	.	..	−1 7	C. I. W.
4	173	1905, May	−1 5	−1 5	−1 0	−1 5	.		.		−1 4	C. & G. S.
5	174	1905, June	−1 5	−1 0	−0 5	+0 5	.		.		−0 6	C. & G. S.
6	176	1905, Mar	−0 5	−0 5	−1 0	−1 0	.		. .	.	−0 8	C. & G S
7	177	1905, Nov	−1 5	−2 3	−1 2	−1 2	−0 8	−1 7	−1 8	−1.1	−1 4	C I W.
8	178	1905, Nov	−1 3	−1 7	−1 9	−1.8	−0 9	−1 5	−1 8	−1 1	−1 5	C. I. W.
9	201	1909, Jan	−0 5	−1 0	−0 5	−0 5	−1 5	−1 0	−1 0	0 0	−0.8	C. I. W.
10	202	1909, Jan	−1 0	−1 0	−1 0	−1.0	−0 5	−0 5	−1 0	−0 5	−0 8	C. I W.
11	205	1909, June	−1 0	−1 5	−0 5	0 0	−1 5	−1 0	−1 0	−2 5	−1 1	C I W.
12	206	1909, Aug	−1 5	−1.5	−1 5	−0 5	−1 5	−0 5	−1 5	−0 5	−1 1	C. I. W.
13	222	1911, Oct.	0 0	0 0	−1 0	0 0	0 0	−1 0			−0 3	C I W.
14	223	1911, Nov.	−0 5	0 0	+0 5	+1 0	−0 5	0 0			+0 1	C I W.
15	241	1915, Jan	+0 5	+1 0	0 0	+1.0	−2 0	−0 5	−1 0	−2 0	−0 4	C I. W.
16	242	1915, Jan	−2 0	−1 5	−1 5	−1 0	+0 5	−1 5	+1 5	−2 0	−0 9	C I W
Means			−1 14	−1 13	−1 05	−0 65	−0 90	−0 95	−0 95	−1 21	−1 01	

[1]All of these dıp circles were made by Dover, excepting C18, the maker of which was Casella, the number gıven ıt beıng that of the Unıted States Coast and Geodetic Survey.

If there be no constant error in the dip-circle method, and at present there is no valid reason for suspecting such a source of error, it would appear that the mean result from so many different dip circles should fall not far from the truth. Granting this, it is seen that the general evidence indicates that the Kew standard gives too great values of the inclination by about 1′.0—a result in good agreement with that (1′.2) found from Table 14C and with that (1′.2) from Table 14D. *The average correction of the Kew inclination standard on I.M.S. is accordingly taken as −1′.1.*

Assembling the various results as referred to I. M. S. (see p. 273), we obtain:

(14) I. M. S.−Kew (Jones magnetometer) = +0′.6 (1908–10).

(14*a*) I. M. S.−Kew (Jones magnetometer) = −0.00008H (1908–10).

(14*b*) I. M. S.−Kew (Barrow dip circle No. 33, needles 1, 2) = −1′.1 (1902–15).

NO. 15.—MAURITIUS OBSERVATORY, MAURITIUS.

The comparisons at the Royal Alfred Observatory, situated at Pamplemousses on the island of Mauritius, were obtained in connection with the shore work of the *Carnegie,* while at Port Louis in August 1911.

The Observatory magnetometer is of the Kew pattern (Elliott No. 24), as also the dip circle (needles 1, 2, 3, and 4). The latter instrument, together with the needles, owing to the moist, tropical conditions, was found to be in bad condition and was replaced in 1913

by an earth inductor (C. I. W. No. 4) constructed in the workshop of the Department of Terrestrial Magnetism; *the correction of this inductor (C. I. W. No. 4) on I. M. S., according to the comparisons at Washington in January 1913 (see Table 27E, p. 264), was found to be* $+0'.3$. As the results with the Observatory dip circle were exceedingly irregular, it is not worth while to give them in detail. The mean result from 8 sets on August 14–15, 1911, is: C. I. W.−Mauritius dip circle $=+4'.4$; if referred to I. M. S. (see p. 273), we have *I. M. S.−Mauritius dip circle* $= +4'.9$.

The C. I. W. instruments used by Dr. H. M. W. Edmonds were: C. I. W. magnetometer No. 4 and Toepfer earth inductor No. 2. The method of comparisons was that of simultaneous observations and exchange of stations. Director A. Walter made the observations for declination and horizontal intensity with the Observatory magnetometer. Two stations were occupied and designated as A and B. A was the central pier in the old pavilion, this pier being used by the Observatory for the D and H observations. B was a temporary station, 6.41 meters south of A and placed in line with A and the former azimuth mark (azimuth $1'.3$ W. of S.). Owing to the pronounced local disturbance[1] near these stations, the attempt was made to have the magnets of both magnetometers at the same level above the ground at each station, viz, 1.53 meters at A and 1.32 meters at B. This could not be done precisely, as the suspended magnets during deflections and oscillations with the Kew magnetometer of the Observatory are at different heights, the average being taken; the Kew declination magnet was, in consequence, 1 inch above the adopted height.

TABLE 15A.—*Results of Declination Comparisons at the Mauritius Observatory, 1911.*

Date	Local mean time		Declination obtained[1]		C I.W.−Mauritius	Remarks
	From	To	C I.W.	Mauritius		
1911	h m	h m	° ′	° ′	′	
Aug. 8	14 47	14 58	−9 20.3	−9 20 3	0 0	C. I. W. magnetometer
9	8 48	8 57	24 5	25 2	+0.7	at B; Observatory
10	9 07	9 15	24.2	25 1	+0.9	magnetometer at A.
12	8 42	8 50	23 3	24 5	+1 2	C. I. W. magnetometer
12	11 48	11 55	24 7	25 2	+0.5	at A; Observatory
12	12 13	12 22	23.8	23 4	−0.4	magnetometer at B.
Mean value of (C. I W.−Mauritius) ...					+0 5	

[1]All results are referred to A, $A=B-42'.9$

TABLE 15B —*Results of Horizontal-Intensity Comparisons at the Mauritius Observatory, 1911.*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.−Mauritius	Weight[2]	Remarks
	From	To	C.I.W.	Mauritius			
1911	h m	h m	γ	γ	γ		
Aug. 8	15 05	16 09	23302	23320	−18	3	C I. W. magnetometer
9	9 09	9 57	323	332	− 9	3	at B, Observatory
10	9 22	10 12	322	329	− 7	3	magnetometer at A.
12	9 20	9 48	310	322	−12	2	C. I. W. magnetometer
12	9 51	10 32	324	326	− 2	2	at A, Observatory
12	10 34	11 05	313	337	−24	2	magnetometer at B
12	11 11	11 37	324	334	−10	2	
Weighted mean value of (C.I.W.−Mauritius).					-11.6γ or $-0\ 00050H$.		

[1]All results are referred to A, $A=B+173\gamma$.
[2]Weight 3 assigned if observations consisted of 1 set of oscillations, 1 set of deflections, and again 1 set of oscillations; if one set of oscillations had to be omitted, the weight 2 was given to the result.

Referring the chief results to I. M. S. (see p. 273), we obtain:

(15) I. M. S.−Mauritius (Elliott magnetometer No. 24)= $+0'.4$ (1911).

(15*a*) I. M. S.−Mauritius (Elliott magnetometer No. 24)= $-0.00065H$ (1911).

(15*b*) I. M. S.−Mauritius (C. I. W. earth inductor No. 4)= $+0'.3$ (Washington, 1913).

[1]See *Terr. Mag*, vol. 16, 1911, pp. 243–246

NO. 16.—MELBOURNE OBSERVATORY, AUSTRALIA.

Various comparisons have been obtained at the Melbourne Observatory since 1906, but the final values for all the Observatory observations are not at present available.

NO. 17.—PILAR OBSERVATORY, ARGENTINA.

During the series of comparisons, obtained in 1911 by the observers of the *Carnegie*, 4 stations were used, viz, Observatory stations Nos. 1 and 8 in the absolute house, and tent stations *B* and *C*, approximately east of the absolute house and in line with Nos. 1 and 8. Station No. 1 is the pier used by the Observatory for the absolute determination of declination and horizontal intensity, while station No. 8 is the pier for the determination of dip. Station No. 8 is 9.02 meters east of pier No. 1, station *B* is 33.04 meters east of station No. 8, and station *C* is 28.1 meters east of station *B*. The Observatory instruments were in 1911: for declination and horizontal intensity, Dover Kew magnetometer No. 138; for inclination, the mean of values as determined with Toepfer earth inductor No. 3 and with Dover dip circle No. 216 (needles 1 and 2).

The C. I. W. instruments used were: C. I. W. magnetometers Nos. 2 and 4, and Toepfer earth inductor No. 2. The method of comparisons followed was that of simultaneous observations with exchange of stations.

TABLE 17 A.—*Results of Declination Comparisons at the Pilar Observatory, 1911.*

Date	Local mean time		Declination obtained[1]		C.I.W.—Pilar 138	Remarks
	From	To	C.I.W.[2]	Pilar 138		
1911	h m	h m	° ′	° ′	′	
Jan. 28	9 49	9 58	+9 08 5	+9 07 4	+1.1	C. I. W. magnetometer 2 at *C*, C. I. W. magnetometer 4 at *B*; Pilar magnetometer 138 at No. 1
28	12 03	12 13	12 2	11 3	+0.9	
28	14 17	14 26	11.4	10 8	+0 6	
28	16 22	16 31	07 9	07 6	+0 3	
30	9 06	9 15	05 9	05 3	+0 6	C. I. W. magnetometer 2 at No 1; C.I.W. magnetometer 4 at *C*; Pilar magnetometer 138 at *B*.
30	11 12	11 21	10 8	10 3	+0 5	
30	14 30	14 40	13 7	13.1	+0 6	
30	16 30	16 40	10.2	09 7	+0 5	
31	8 58	9 07	06.2	06 0	+0 2	C. I. W magnetometer 2 at *B*, C. I. W. magnetometer 4 at No. 1; Pilar magnetometer 138 at *C*.
31	11 04	11 14	11.1	10.4	+0 7	
31	14 18	14 28	10 4	10 4	0 0	
31	17 33	17 43	08 4	08 7	−0 3	
Mean value of (C. I. W.—Pilar 138) ..					+0 5	

[1]All values are referred to station *B*; $B=$No. $1-0'.9$, $B=C+0'.4$.
[2]Mean result from both C. I. W. magnetometers, referred to standard.

TABLE 17 B.—*Results of Horizontal-Intensity Comparisons at the Pilar Observatory, 1911*

Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Pilar 138	Remarks
	From	To	C.I.W.[2]	Pilar 138		
1911	h m	h m	γ	γ	γ	
Jan. 28	10 07	11 45	25652	25678	−26	C. I. W. 2 at *C*; C. I. W. 4 at *B*; Pilar 138 at No. 1.
28	14 37	16 13	668	686	−18	
30	9 28	11 03	670	697	−27	C. I. W. 2 at No. 1; C. I. W. 4 at *C*, Pilar 138 at *B*.
30	14 52	16 21	651	665	−14	
31	9 23	10 56	684	707	−23	C I. W. 2 at *B*, C. I. W. 4 at No. 1, Pilar 138 at *C*.
31	15 59	17 28	640	664	−24	
Mean value of (C. I. W.—Pilar 138) ..					−22 0γ or −0.00086*H*.	

[1]All values are referred to station *B*, $B=$No. $1-29.8\gamma$; $B=C+2\ 9\gamma$.
[2]Mean result from both magnetometers, referred to standard.

The next comparisons at the Pilar Observatory were obtained by Observer H. F. Johnston in the course of his field work in South America in 1913. He used C. I. W. magnetometer No. 19, an instrument of the universal type (see *Terrestrial Magnetism*, v. 16, 1911, pp. 9–12). The comparisons were made chiefly for declination and horizontal intensity; those for inclination comprised but two sets, and as they were intended primarily to control the corrections of the needles of No. 19, the results are not given here.

TABLE 17 C.—*Results of Inclination Comparisons at the Pilar Observatory, 1911.*

Date	Local mean time		Station		Inclination obtained[1]		C.I.W.—Pilar
	From	To	C.I.W.	Pilar	C.I.W.	Pilar	
1911	h m	h m			° ′	° ′	′
Feb. 1	13 43	14 09	B	8	−25 52 2	−25 52 3	+0 1
1	14 16	15 26	B	8	52.8	52 3	−0 5
1	15 51	16 29	B	8	54 8	54 0	−0 8
2	9 19	9 46	C	B	53 5	52 7	−0 8
2	10 43	11 11	C	B	52 7	52 5[2]	−0 2
2	11 47	12 07	C	B	53 1	52.7	−0 4
2	15 49	16 15	8	C	54 3	54.9	+0 6
2	16 48	17 10	8	C	54.4	54 5[2]	+0 1
2	17 26	17 50	8	C	54.6	54 8	+0.2
Mean value of (C. I W.—Pilar)					.	. .	−0 2

[1]All values are referred to station *B*; *B*=No. 1−2′.8; *B*=*C*.
[2]These values are the means of observed dips with dip circle No. 216 and of preceding and following values with the earth inductor.

Since the comparisons of 1911, a new Dover-Kew magnetometer, No. 175, has been used as the Observatory standard; the observer for declination and horizontal intensity with this instrument was Director L. G. Schultz. For the inclination observations by the Observatory, Dover dip circle 216 (2 needles) and Toepfer earth inductor No. 3 were used, the observers being, for the former, Mr. O. Lützow-Holm, and for the latter, Mr. S. Stranger.

The same stations were used as in 1911. Quoting from Director Schultz's report:

"The absolute building was cleared of all disturbing substances and everything was arranged, as nearly as possible, as for the 1911 comparisons.

"Heavy wooden (algarroba) piers, 30 cm. section, were planted at stations *B* and *C* after the 1911 comparisons. They extend 2 meters into the ground and nothing but earth was used to fix them in place. They are provided with copper foot-plates fixed so that when the foot-screws of an instrument are adjusted in the grooves of the plates the center of the instrument lies in the vertical line which coincides with the center of the small pegs put down by the *Carnegie* observers. The slight differences in the azimuths used in these comparisons are due to the fact that the azimuth of the large stone monument (mark 1) has been determined from *B* and *C* by a large number of star observations and the centers of *B* and *C* have been brought rigidly into line with the centers of the four piers in the absolute building and the central line of mark 1.

"A commodious wooden structure, with padded walls, was placed over station *B* some time before these comparisons; also a simple wooden building over station *C*; and the utmost care was exercised to avoid modifying the magnetic conditions at both stations."

The exchange of stations, to eliminate station-differences, was made as shown in the table of results. The station differences, $B-C$, obtained from the present comparisons are practically the same as those for 1911, showing that the structures put over these points since then have not affected the surroundings. However, the station differences, $B-$No. 1 and $B-$No. 8, are somewhat different, apparently bearing out the suspicion that in the 1911 work there was at the time some disturbing influence in the absolute building.

Director Schultz states that "the scale coefficients of all variometers were determined a few days after these comparisons and the results show no appreciable change in the values since the comparisons of 1911."

The times of beginning and ending, as given in the tables, are the means for the two observers.

TABLE 17 D.—*Results of Declination Comparisons at the Pilar Observatory, 1913*

Date	Local mean time		Station		Declination obtained[1]		C I.W − Pilar 175
	From	To	C I.W	Pilar	C I W.	Pilar 175	
1913	h m	h m			° ′	° ′	′
June 19	15 02	15 11	*C*	*B*	+8 47 6	+8 48 0	−0 4
19	15 23	15 33	*C*	*B*	47.4	47 6	−0 2
20	9 19	9 28	*C*	*B*	46 1	46 7	−0 6
20	11 26	11 38	*C*	*B*	47 4	47 4	0 0
20	11 47	11 56	*C*	*B*	47 4	47 6	−0 2
20	12 04	12 13	*C*	*B*	47 8	48 1	−0 3
21	8 49	8 58	1	*C*	46 8	46 5	+0 3
21	10 35	10 44	1	*C*	45 2	44 8	+0 4
21	11 05	11 14	1	*C*	45 7	46 3	−0 6
21	11 34	11 43	1	*C*	46 6	46 9	−0 3
21	11 51	12 00	1	*C*	47 2	47 5	−0 3
21	15 03	15 12	1	*C*	48 7	49 3	−0.6
21	16 33	16 43	1	*C*	46 0	46 4	−0 4
23	8 45	8 55	*B*	1	47 4	47 4	0 0
23	10 24	10 33	*B*	1	46 8	47 2	−0 4
23	10 54	11 03	*B*	1	47 2	47 2	0 0
23	14 21	14 31	*B*	1	49 0	48 9	+0 1
23	14 51	15 00	*B*	1	49 1	49 5	−0 4
23	16 30	16 40	*B*	1	45 9	46 4	−0 5
Mean value (C I W.−Pilar 175) .							−0 2

[1]All values are referred to station *B*, *B*=No. 1−1′ 4; *B*=*C*+0′ 4

TABLE 17 E.—*Results of Horizontal-Intensity Comparisons at the Pilar Observatory, 1913.*

Date	Local mean time		Station		Hor int obtained[1]		C I W − Pilar 175
	From	To	C.I.W.	Pilar	C I.W.	Pilar 175	
1913	h m	h m			γ	γ	γ
June 20	9 44	11 24	*C*	*B*	25615	25618	− 3
20	13 47	15 03	*C*	*B*	609	604	+ 5
20	15 16	16 24	*C*	*B*	606	618	−12
21	9 13	10 33	1	*C*	622	625	− 3
21	13 37	14 50	1	*C*	612	624	−12
21	15 19	16 27	1	*C*	621	616	+ 5
23	9 04	10 14	*B*	1	619	623	− 4
23	11 08	14 16	*B*	1	612	618	− 6
23	15 07	16 26	*B*	1	616	617	− 1
Mean value of (C I W.−Pilar 175)							− 3.4γ or − 0 00013*H*

[1]All values are referred to station *B*; *B*=*C*−2 8γ; *B*=No 1−19.2γ

Assembling the various results and referring them to I. M. S. (see p. 273), we obtain:

(17) I. M. S.−Pilar (Dover magnetometer No. 138)= +0′.4 (1911).

(17*a*) I. M. S.−Pilar (Dover magnetometer No. 138)= −0.00101*H* (1911).

(17*b*) I. M. S.−Pilar (Dip circle No. 216 and inductor No. 3)= +0′.3 (1911).

(17*c*) I. M. S.−Pilar (Dover magnetometer No. 175)= −0′.3 (1913).

(17*d*) I. M. S.−Pilar (Dover magnetometer No. 175)= −0.00028*H* (1913).

NO. 18—POLA OBSERVATORY, AUSTRIA.

For the comparisons at the Pola Observatory, the C. I. W. observations by Mr. J. C. Pearson were all made on the main pier in the absolute room used for the Observatory instruments. Eye readings of the variation instruments were made simultaneously by the Observatory for declination and horizontal intensity; for inclination, observations were made with the Observatory earth inductor in the middle of each set of observations by Mr. Pearson with Dover dip circle No. 177 (needles 1, 2, 5, and 6). For the D and H observations, Mr. Pearson used C. I. W. magnetometer No. 5. The Observatory standards are: Bamberg magnetometer No. 7904 and a Wild earth inductor.

TABLE 18 A.—*Results of Declination Comparisons at the Pola Observatory, 1910*

Date	Local mean time		Declination obtained		C.I.W.—Pola
	From	To	C.I.W.	Pola	
1910	h m	h m	° ′	° ′	′
Feb. 8	8 52	9 01	−8 30.9	−8 30 3	−0 6
8	11 15	11 24	31 9	31 6	−0 3
8	14 06	14 15	32 1	32.1	0 0
8	15 57	16 06	31 2	31 1	−0 1
9	8 25	8 34	30 0	29 7	−0 3
9	10 15	10 24	31 4	30 9	−0.5
9	14 12	14 21	35 0	34 6	−0 4
9	15 50	15 59	32 7	32 0	−0 7
10	8 21	8 30	31 6	30 9	−0 7
10	9 59	10 07	32 3	32.1	−0 2
10	10 23	10 32	32 7	32 7	0 0
10	11 47	11 56	34.0	34 1	+0.1
14	8 35	8 44	30 8	30 2	−0 6
14	10 18	10 27	31.6	31.8	+0.2
Mean value of (C. I. W.—Pola). . .				..	−0 3

TABLE 18 B.—*Results of Horizontal-Intensity Comparisons at the Pola Observatory, 1910.*

Date	Local mean time		Hor. int. obtained		C.I.W.—Pola
	From	To	C.I.W.	Pola	
1910	h m	h m	γ	γ	γ
Feb. 8	9 42	11 06	22214	22204	+10
8	14 19	15 54	225	212	+13
9	8 39	10 12	219	208	+11
9	14 26	15 48	220	210	+10
10	8 33	9 57	220	208	+12
10	10 34	11 45	223	206	+17
14	8 46	10 14	224	214	+10
Mean value of (C. I. W.—Pola)...				.	+11 9γ or + 0 00054H

TABLE 18 C.—*Results of Inclination Comparisons at the Pola Observatory, 1910.*

Date	Local mean time		Inclination obtained		C.I.W.—Pola
	From	To	C.I.W.	Pola	
1910	h m	h m	° ′	° ′	′
Feb. 10	15 21	16 40	+60 03.9	+60 04 3	−0 4
11	8 37	9 51	05.2	04.6	+0 6
11	10 32	11 47	04 8	04 9	−0 1
11	14 29	15 38	04 8	04.7	+0 1
12	8 36	9 50	03 8	03 4	+0 4
12	10 26	11 39	04 0	04.4	−0 4
12	14 25	15 27	04.2	03 7	+0 5
Mean value of (C. I. W.—Pola).				. . .	+0.1

Referring the mean results to I. M. S. (see p. 273), we obtain:

(18) I. M. S.−Pola (Bamberg magnetometer No. 7904) = $-0'.4$ (1910).

(18*a*) I. M. S.−Pola (Bamberg magnetometer No. 7904) = $+0.00039H$ (1910).

(18*b*) I. M. S.−Pola (Wild earth inductor) = $+0'.6$ (1910).

NO. 19.—PORTO RICO OBSERVATORY, VIEQUES, PORTO RICO.

The comparisons at the Porto Rico Magnetic Observatory of the United States Coast and Geodetic Survey were obtained by the observers of the *Carnegie*. The following 3 stations were occupied: the two observing piers in the absolute house, regularly used for the magnetometer and for the earth inductor; and an auxiliary station used for dip only. The latter station, designated 1, was distant 24.2 meters in a line 144° 12'.2 southwest of the regular azimuth-station of the Observatory. The Observatory absolute instruments were: for declination and horizontal intensity, Cooke magnetometer No. 31 (India Magnetic Survey pattern); and for inclination, Schulze earth inductor No. 1. The tabulated values of the Observatory are the results from the magnetograms, as standardized before and after the work of the *Carnegie* observers. The standards of the Observatory are based on those at the Cheltenham Magnetic Observatory of the Coast and Geodetic Survey, the observer-in-charge being at the time Mr. G. Hartnell. The *Carnegie* observers were Mr. W. J. Peters (Chief of Party), and Messrs. E. Kidson and C. C. Craft; the instruments used by them were: C. I. W. magnetometers Nos. 2 and 4; Dover dip circle No. 201, with needles Nos. 1 and 2.

The result of the horizontal-intensity comparison showed that a curious change had taken place in the Cooke magnetometer No. 31 in recent years. Thus, quoting from page 83, Appendix No. 3, Report of the United States Coast and Geodetic Survey for 1911:

> "As a result of comparisons at Cheltenham in 1903 and at the Porto Rico Observatory in 1905, $+0.00095H$ was adopted as the correction to be applied to horizontal-intensity results with magnetometer No. 31 to reduce them to the Cheltenham standard. In July 1910 the yacht *Carnegie* of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, stopped at Vieques on her way to South America, and her instruments were compared with those of the Porto Rico Observatory. These comparisons indicated that some change had taken place in magnetometer No. 31 since the comparisons of 1905. To verify this, magnetometer No. 36 was compared at Cheltenham in January 1911; with No. 31 at the Porto Rico Observatory in February and April; and again at Cheltenham upon its return. These comparisons gave for the correction to No. 31 in March 1911, $-0.0005H$. A careful scrutiny of the Observatory records failed to find any evidence of a sudden change in magnetometer No. 31 which might account for this change in its relation to the standard magnetometer, and it was therefore considered best to assume a gradual change from $+0.00095H$ in January 1907 to $-0.0005H$ in March 1911."

The H-values for the Porto Rico Observatory, as supplied by the Coast and Geodetic Survey, were corrected as stated in this quotation; as the values thus derived are the ones referred to the Cheltenham standard, the difference given below, namely, C. I. W.−Porto Rico (referred to Cheltenham standard) = $-0.00082H$, is found to be practically the same as the result from the directly-observed quantities at Cheltenham (see p. 228).

The declination correction of magnetometer No. 31 on the Cheltenham standard as applied to the furnished values was 0'.0.

The inclination values as tabulated all refer to the same station, namely, the earth-inductor pier (E. I.) in the absolute house, the earth inductor having been removed during the period of the *Carnegie* observations. On July 26, dip circle No. 201 was mounted on this dip pier and on July 27 at the auxiliary station No. 1. The station-difference was determined by simultaneous observations on July 26 and 27 between the *Carnegie* dip circles 201 and 189. To the Observatory values a correction of $-1'.0$ was applied by the Coast and Geodetic Survey to refer them to the Cheltenham standard.

TABLE 19 A.—*Results of Declination Comparisons at the Porto Rico Observatory, 1910*

Date	Local mean time From	Local mean time To	Declination obtained C.I.W.	Declination obtained Porto Rico	C.I.W.—Porto Rico	Remarks
1910	h m	h m	° ′	° ′	′	
July 29	9 53	10 02	−2 20 6	−2 20 9	+0.3	C. I. W. magnetometer 4
29	14 06	14 15	22 2	23 3	+1.1	
29	16 05	16 14	23 0	23 7	+0 7	
30	9 32	9 41	19 1	19 9	+0.8	C. I. W. magnetometer 2.
30	11 23	11 32	21 8	22 5	+0 7	
30	13 17	13 26	23 1	23 5	+0.4	
30	17 56	18 05	23 1	23 5	+0 4	
Mean value of (C. I. W.—Porto Rico)					+0.6	

TABLE 19 B.—*Results of Horizontal-Intensity Comparisons at the Porto Rico Observatory, 1910.*

Date	Local mean time From	Local mean time To	Hor. int. obtained C. I. W.	Hor. int. obtained Porto Rico	C. I. W.—Porto Rico	Remarks
1910	h m	h m	γ	γ	γ	
July 29	10 22	11 42	28830	28859	−29	C. I. W. magnetometer 4, deflection distance 30 cm only; weight 1
29	14 31	15 55	814	839	−25	
30	9 55	11 09	816	851	−35	C. I. W. magnetometer 2; weight 2.
30	13 37	14 42	835	844	− 9	
Mean value of (C. I. W.—Porto Rico)					−23.7γ or −0.00082*H*.	

TABLE 19 C.—*Results of Inclination Comparisons at the Porto Rico Observatory, 1910*

Date	Local mean time From	Local mean time To	Inclination obtained[1] C.I.W.	Inclination obtained[1] Porto Rico	C.I.W.—Porto Rico	Remarks
1910	h m	h m	° ′	° ′	′	
July 26	10 33	11 12	+49 52 2	+49 51.9	+0.3	Dip circle 201 at E. I. pier.
26	11 15	11 57	53 3	52.0	+1 3	
26	13 56	14 27	54 1	52 6	+1 5	
27	10 03	10 31	50 8	51 0	−0 2	Dip circle 201 at Sta. 1.
27	10 37	11 05	50 8	51 2	−0 4	
27	11 21	11 50	51.6	51 3	+0 3	
Mean value of (C. I. W.—Porto Rico)...					+0.5	

[1]All values are referred to E. I pier; station E. I. = station No. 1—9′.2.

Referring the mean results to I. M. S. (see p. 273), we obtain:

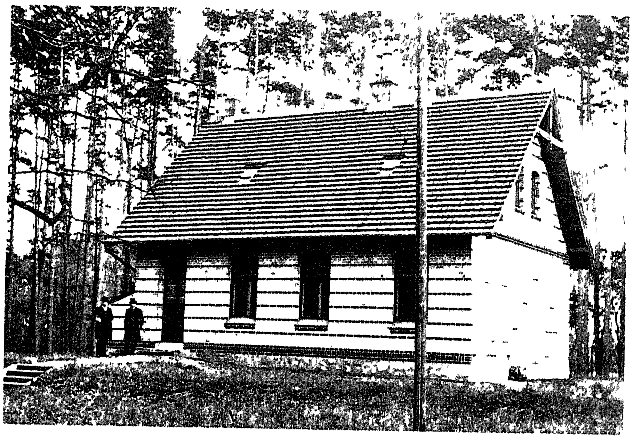
(19) I. M. S.—Porto Rico (Cooke magnetometer No. 31 referred to Cheltenham) = +0′.5 (1910).

(19*a*) I. M. S.—Porto Rico (Cooke magnetometer No. 31 referred to Cheltenham) = −0.00097*H* (1910).

(19*b*) I. M. S.—Porto Rico (Schulze inductor No. 1 referred to Cheltenham) = +1′.0 (1910).

NO. 20.—POTSDAM OBSERVATORY, GERMANY.

All observations by the C. I. W. observer (Mr. J. C. Pearson) for the comparisons at the Potsdam Observatory, were made on what is called "Pier No. 5." There was no exchange of stations as the Observatory had already made tests showing that station differences were negligible. The values given for Potsdam depend on the final determinations of the base-lines.



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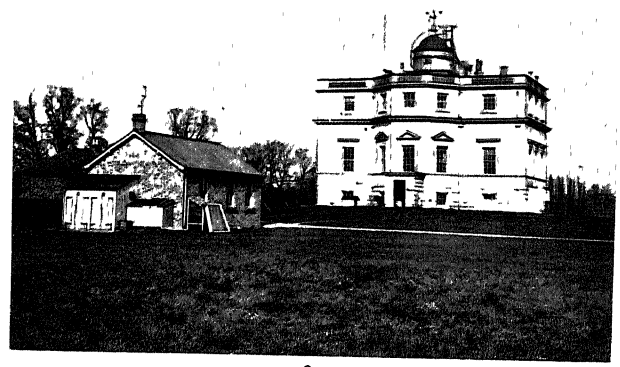

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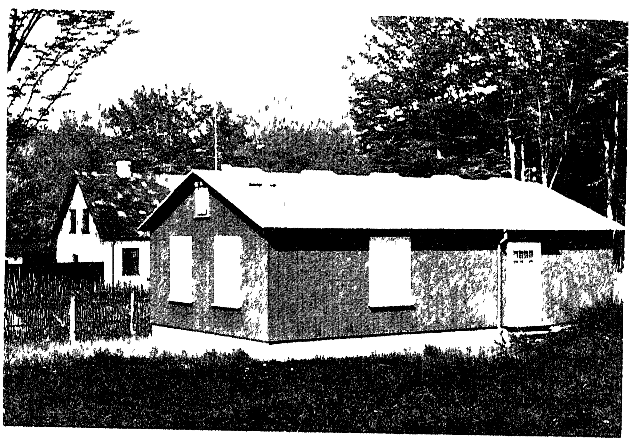

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6

Views of Magnetic Observatories in Europe, Russia, and Egypt.

1 Seddin, near Potsdam, Germany
2. Kew, England
3 Rude Skov, near Copenhagen, Denmark
4 Falmouth, England
5 Helwan, near Cairo, Egypt
6 Tiflis, Transcaucasia

The instruments used by Mr. Pearson were C. I. W. magnetometer No. 5 and Dover dip circle No. 177 (needles 1, 2, 5 and 6).

TABLE 20 A.—*Results of Declination Comparisons at the Potsdam Observatory, 1910.*

Date	Local mean time		Declination obtained		C.I.W.—Potsdam
	From	To	C.I.W.	Potsdam	
1910	h m	h m	° ′	° ′	′
Feb. 21	14 29	14 38	−9 08.4	−9 08.4	0.0
21	16 44	16 53	03.6	03.9	+0.3
22	8 17	8 26	04.1	04.6	+0.5
22	10 22	10 31	05.5	06.2	+0.7
22	10 48	10 57	06.4	07.0	+0.6
22	12 27	12 36	08.0	08.2	+0.2
22	14 30	14 39	08.4	08.8	+0.4
22	16 22	16 31	07.5	07.3	−0.2
23	12 04	12 13	08.7	09.1	+0.4
23	13 53	14 02	08.3	08.8	+0.5
24	8 21	8 30	04.4	04.6	+0.2
24	10 01	10 10	04.2	04.5	+0.3
24	10 22	10 31	04.6	05.2	+0.6
24	12 02	12 11	09.1	09.3	+0.2
Mean value of (C. I. W.—Potsdam)					+0.34

TABLE 20 B.—*Results of Horizontal-Intensity Comparisons at the Potsdam Observatory, 1910.*

Date	Local mean time		Hor. int. obtained		C.I.W.—Potsdam
	From	To	C.I.W.	Potsdam	
1910	h m	h m	γ	γ	γ
Feb. 21	14 50	16 39	18833	18830	+3
22	8 31	10 18	846	835	+11
22	11 01	12 24	827	830	−3
22	14 44	16 17	840	835	+5
23	12 18	13 49	830	825	+5
24	8 34	9 59	854	845	+9
24	10 34	11 59	837	835	+2
Mean value of (C. I. W.—Potsdam) .. .					+4.6γ or +0.00024H

TABLE 20 C.—*Results of Inclination Comparisons at the Potsdam Observatory, 1910*

Date	Local mean time		Inclination obtained		C.I.W.—Potsdam
	From	To	C.I.W.	Potsdam	
1910	h m	h m	° ′	° ′	′
Feb. 24	15 16	16 37	+66 19.1	+66 19.2	−0.1
25	9 02	10 22	20.9	21.4	−0.5
25	14 24	15 49	21.4	21.6	−0.2
25	15 58	17 26	23.3	24.1	−0.8
28	9 12	10 38	19.7	20.2	−0.5
28	11 24	12 46	19.7	19.8	−0.1
28	15 26	16 58	20.2	20.4	−0.2
Mean value of (C. I. W.—Potsdam)					−0.34

Since the Potsdam Magnetic Observatory is generally used as a base station for the magnetic work in Germany and her colonies, it will be desirable to strengthen, as far as possible, the mean results found in Tables 20 A, 20 B, and 20 C.

Declination.—Dr. F. Linke, in a letter dated Göttingen, January 6, 1908, stated that the Tesdorpf magnetometer No. 1975, used at the Samoa Observatory in 1906, gave a value of west magnetic declination at Potsdam $0'.74$ higher than that obtained with the Potsdam standard. Hence, since we regard west declination as negative:

(*a*) Potsdam − Tesdorpf No. 1975 = $+0'.74$ (Linke, 1907).

From the C. I. W. comparisons at Samoa in 1906 (Table 23 A, p. 257) it was found from 2 sets:

(*b*) C. I. W. − Tesdorpf No. 1975 = $+1'.10$ (C. I. W. 1906).

Combining (*a*) and (*b*) we get:

(*c*) C. I. W. − Potsdam = $+0'.36$ (1906–07),

which is in good agreement with the value ($+0'.34$) found above in Table 20 A.

Horizontal Intensity.—According to H-comparisons made by Dr. Linke in October and November 1904, between Tesdorpf magnetometer No. 1975 and the standards at Potsdam and Cheltenham, it was found that with the relative constants for No. 1975 as determined at Potsdam,[1] (Potsdam − Cheltenham) = $-35\gamma = -0.00174H$.

It was pointed out by L. A. Bauer[2] in 1907 that if this relation be correct, the Potsdam standard in 1904 gave values of H too low on the order of $.001H$, whereas it had been shown[2] that the Cheltenham standard gave values about $0.001H$ too high. This conclusion has been verified; for, since the publication of Linke's result, the Potsdam Observatory has found that for the period March 24, 1904 to April 30, 1905, its values of the horizontal intensity, because of a torsion error, required to be increased[3] by $12.5\gamma = +0.00066H$. Hence from the Potsdam corrected H-values:

(*d*) Potsdam − Cheltenham = $-0.00108H$ (1904, corrected).

From the C. I. W. comparisons at Cheltenham, 1908–10, it was found (Table 7 B, series I, II, and III, p. 228) that:

(*e*) C. I. W. − Cheltenham = $-0.00088H$ (1908–10).

If we may assume that the relation between the Potsdam corrected standard and the Cheltenham standard, for which it is known that the same constants have been used throughout, has remained unchanged between 1904 and 1910, we can combine (*d*) and (*e*) and get:

(*f*) C. I. W. − Potsdam = $+0.00020H$ (1904–10); which is in excellent agreement with the directly-observed quantity ($+0.00024H$) given above in Table 20 B.

We might also get an approximate check from the C. I. W. comparisons at the Samoa Observatory, where from 2 sets on May 3, 1906, it was found (p. 257) that C. I. W. − Samoa (Tesdorpf No. 1975 referred to Potsdam) = $+0.00046H$. From the data at hand, it can not be determined definitely, however, just how far, in the standardizations of Tesdorpf No. 1975 at Potsdam, all corrections for the Potsdam standard have been taken into account. An indirect and approximate check can also be derived by means of Dubinsky's preliminary results at Kew and Potsdam in 1908. Referring to Table 31 A, p. 270, it is found that (Kew − Potsdam) is $-0'.5$ (for declination), $+0.00011H$ (for horizontal intensity), and $+1'.6$ (for inclination). With the aid of the C. I. W. comparisons at Kew in March 1908 and March 1910 (Tables 14 A, 14 B, and 14 C, pp. 241–242) we find that (C. I. W. − Potsdam) is $+0'.2$ (for declination), $+0.00018H$ (for horizontal intensity), and $-0'.1$ (for inclination). It will be seen that these indirect results for declination and inclination are in satisfactory agreement with the directly-observed values given in Tables 20 A and 20 C. Combining the two approximate H checks ($+0.00046H$ and $+0.00018H$), giving the latter double weight, we get $+0.00027H$, against the directly-observed value, $+0.00024H$, found in Table 20 B.

[1] Linke, F. Vergleich der Messung der Horizontalintensitat des Erdmagnetismus in Potsdam und Cheltenham im Jahre 1904; *Nach Gesell der Wissenschaften, Göttingen, Math.-Phys. Kl*, 1907

[2] Bauer, L. A., Preliminary note on an "international magnetic standard", *Terr Mag*, v. 12, 1907, p 162

[3] Ergebnisse der magnetischen Beobachtungen in Potsdam, in den Jahren 1903 und 1904, Berlin, 1908, p xvi, and Ergebnisse . . . im Jahre 1905, Berlin, 1908, p. 16.

Inclination.—Since many of the earth inductors of the Wild-Eschenhagen pattern, made by Toepfer or by Schulze, are tested at Potsdam, it will be desirable to get another check upon the quantity found in Table 20 C. This is afforded by means of Table 20 D.

TABLE 20 D —*Results of Inclination Comparisons between the Standard Earth Inductors at Potsdam and Cheltenham, 1906–12*

[The standard earth inductor at the Potsdam Observatory is Schulze No 1 (Wild-Eschenhagen pattern) and at the Cheltenham Observatory in Maryland the standard is the large Wild-Edelmann earth inductor No 26. The earth inductors, the comparison-results of which at Potsdam and Cheltenham are given in the table, are all of the Wild-Eschenhagen pattern as made by Schulze of Potsdam It will be seen that, with the exception of No 48, they were purchased by the United States Coast and Geodetic Survey, which organization courteously communicated its results to us]

Maker and number	Owner of Earth Inductor	Date of Potsdam Comparisons	Potsdam – Earth Inductor	Date of Cheltenham Comparisons	Cheltenham – Earth Inductor	Potsdam – Cheltenham	
						ΔI	Weight
			′		′	′	
Schulze 43	U S C. & G S	1906, Aug .	−0 29	1906	−0 91	+0 62	1
48	C I W	1907, Feb	−0 27	1908, Mar , Apr	−0 54	+0 27	2
63	U S C. & G S	1911, Apr	−0 03	1911, June	−0 36	+0 33	2
89	U. S C & G S	1912, Aug	+0 10	1912, Nov	−0 26	+0 36	2
Weighted mean value of (Potsdam – Cheltenham) .						+0 36	

Hence we have from the table:

(*g*) Potsdam – Cheltenham = +0′.36 (1906–12).

From the C. I. W. comparisons 1908–10 (Table 7C, series I, II, and III, p. 229) we find:

(*h*) C. I. W. – Cheltenham = +0′.06.

Combining (*g*) and (*h*) we get:

(*i*) C. I. W. – Potsdam = –0′.30 (1908–10), which agrees well with the directly-observed quantity –0′.34, in Table 20C.

Weighting the various results according to their reliability and referring them to I. M. S. (see p. 273), we obtain:

(20) I. M. S. – Potsdam (Wanschaff magnetometer) = +0′.2 (1910).
(20*a*) I. M. S. – Potsdam (Wanschaff magnetometer) = +0.00008*H* (1910).
(20*b*) I. M. S. – Potsdam (Schulze inductor No. 1) = +0′.2 (1910).

NO. 21.—RIO DE JANEIRO OBSERVATORY, AT VASSOURAS, BRAZIL.

The comparisons of 1913 were obtained by Observer H. F. Johnston, in the course of his field work, at Vassouras, the new site of the magnetic observatory belonging to the National Observatory of Rio de Janeiro. The site is in the suburbs of the little city of Vassouras, which is distant 3 hours by rail from Rio de Janeiro, and is located in a district where the danger of disturbing influences from electric lines in the near future is not to be feared. The stations occupied, designated *A* and *B*, are the two concrete piers, 10.9 feet (3.32 meters) apart, in the non-magnetic house for absolute observations. Pier *A* is the larger one and is to the north of pier *B*.

At *A* the mark used was the left edge of a brass pin in the Observatory azimuth mark, about 90 meters from the building, the azimuth, as supplied by Dr. Morize, Director of the Observatory, being 146° 40′.4 west of true south. At *B* the azimuth mark was the left edge of a white house on a hill about 1 mile (1.6 kilometers) distant; its azimuth, as supplied by Dr. Morize, is 174° 58′.8 west of true south.

The Observatory instruments used in these comparisons were magnetometer No. 20 by Cooke and Son, Survey of India pattern, and Negretti and Zambra dip circle No. 114, with needle No. 2. The C. I. W. instrument used by Mr. Johnston was universal magnetometer No. 19, with dip needles 1 and 2; unfortunately, it was found necessary to reject

all observations with needle No. 1 for inclinations ranging from $-14°.5$ to $-19°$, because of the very erratic behavior of the needle in this region of dip. The inclination comparisons are thus dependent upon only one needle (No. 2) for each instrument. Dr. Morize states, under date of June 23, 1913, that he expects to use for the absolute observations a Wild earth inductor; accordingly, as additional comparisons will be obtained in the near future, only the mean result of the 1913 inclination comparisons, referred to I. M. S. (see p. 273), is given, namely: I. M. S.—Rio de Janeiro dip circle 114 (needle 2) = $-4'.2$ (provisional result).

TABLE 21 A.—*Results of Declination Comparisons at the Rio de Janeiro (Vassouras) Observatory, 1913*

Date	Local mean time		Declination obtained[1]		C I W — Rio de Janeiro	Remarks
	From	To	C I W.	Rio de Janeiro		
1913	h m	h m	° ′	° ′	′	
May 21	13 38	13 48	−10 05 2	−10 05 6	+0 4	C. I W magnetometer 19 at *A*; Rio de Janeiro magnetometer 20 at *B*.
22	8 56	9 09	06 3	07 1	+0 8	
22	14 49	15 01	06 2	07 0	+0 8	
23	9 00	9 11	06 9	07 3	+0 4	
23	13 12	13 23	05 7	06 6	+0 9	
25	11 09	11 20	05 2	05 3	+0 1	
23	14 18	14 30	05 2	05 8	+0 6	C I. W. magnetometer 19 at *B*, Rio de Janeiro magnetometer 20 at *A*.
24	9 59	10 12	03 6	04 8	+1 2	
24	10 38	10 48	03.8	04 4	+0 6	
24	13 59	14 08	04 7	05 2	+0 5	
24	14 32	14 42	05 7	05 8	+0 1	
25	9 23	9 33	04.1	04 8	+0 7	
Mean value of (C. I W.—Rio de Janeiro)					+0 6	

[1]All values are referred to station *A*; $A = B - 1'.6$.

TABLE 21 B.—*Results of Horizontal-Intensity Comparisons at the Rio de Janeiro (Vassouras) Observatory, 1913.*

Date	Local mean time		Hor int obtained[1]		C I.W — Rio de Janeiro	Remarks
	From	To	C I W.	Rio de Janeiro		
1913	h m	h m	γ	γ	γ	
May 22	10 53	14 27	24653	24648	+ 5	C I magnetometer 19 at *A*, Rio magnetometer 20 at *B*
23	9 46	11 28	663	675	−12	
23	14 51	15 55	628	639	−11[2]	
24	11 07	13 38	657	658	− 1	C I. W. magnetometer 19 at *B*, Rio magnetometer 20 at *A*
24	14 59	16 41	636	635	+ 1	
25	9 53	10 39	650	660	−10[2]	
Weighted mean value of (C I.W.—Rio de Janeiro)					−3 5γ or −0 00014*H*	

[1]All values are referred to station *A*, $A = B + 1\gamma$.
[2]Half set, weight, 0.5.

Referring the mean results to I. M. S. (see p. 273), we obtain:

(21) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 20) = $+0'.5$ (1913).
(21*a*) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 20) = $-0.00029H$ (1913).

NO. 22.—ROME OBSERVATORY, ITALY.

The comparisons of the magnetic instruments of the Ufficio Centrale di Meteorologia e Geodinamica at Rome with the standards of the Carnegie Institution of Washington were made near Terracina, Italy, in 1911, and again in 1913. Two stations, designated *A* and *B*, were occupied on the rifle range southwest of Terracina. Station *A* is 64.5 meters east-northeast of northeast corner of target pit and 64.5 meters northeast of center of top step of flight leading into target pit at its northwest end; the semaphore on Cape Circello

is in true bearing 67° 25′.3 W. of S. Station B is 47 meters south-southwest of station A, 18 meters north-northeast of northeast corner of target pit and 20.5 meters northeast of center of top step of flight leading into target pit at northwest corner; it was marked by tent peg driven flush with ground. The true bearings of marks at B are: semaphore on Cape Circello, 67° 34′.4 W. of S.; cone-topped tower on hospital in Terracina, 227° 09′.6 W. of S. The azimuths given are the mean results of all observations in 1911 and 1913.

The instruments used by Director Palazzo were Dover-Schneider magnetometer No. 122, and Dover dip circle No. 51 (needles 1 and 2 in 1911, and needles 1, 2, 5, 6, 15, and 16 in 1913).[1] The C. I. W. observations were made in 1911 by Mr. W. H. Sligh, using C. I. W. magnetometer No. 7 and Dover dip circle No. 202 (needles 1 and 2); in 1913 the observer was Mr. W. F. Wallis, who used C. I. W. magnetometer No. 10 and Dover dip circle No. 202 (needles 1, 2, 5, and 7).

TABLE 22 A.—*Results of Declination Comparisons at Rome (Terracina), 1911 and 1913.*

Series	Date	Local mean time		Declination obtained[1]		C.I.W.—Rome	Remarks
		From	To	C.I.W.	Rome		
	1911	h m	h m	° ′	° ′	′	
I	Oct. 20	10 32	10 41	−8 22.2	−8 22.5	+0.3	C. I. W. magnetometer 7 at B, Rome magnetometer at A.
	20	10 51	11 00	22.4	22.7	+0.3	
	20	11 08	11 17	23.7	23.2	−0.5	
	20	11 27	11 36	24.2	23.9	−0.3	
	20	11 47	11 56	24.8	24.7	−0.1	
	21	16 42	16 51	22.5	22.7	+0.2	C. I. W. magnetometer 7 at A; Rome magnetometer at B.
	21	16 58	17 07	22.6	23.7	+1.1	
	Mean	.	. . .	. .	. . .	+0.1	Weight, 1.0
	1913						
II	Nov 12	10 56	11 05	−8 03.7	−8 04.2	+0.5	C. I. W. magnetometer 10 at B, Rome magnetometer at A.
	13	9 07	11 09	02.3	02.6	+0.3[2]	
	16	10 02	11 20	03.6	03.3	−0.3[2]	C. I. W. 10 at A, Rome at B.
	17	9 42	10 57	02.7	03.7	+1.0[2]	C. I. W. 10 at B, Rome at A
	Mean	.	.	. .	.	+0.3	Weight, 1.0
Mean value of (C. I. W.—Rome) from I and II .						+0.2	

[1]All values are referred to A, $A=B-0'.4$
[2]Weight, 4.0.

TABLE 22 B.—*Results of Horizontal-Intensity Comparisons at Rome (Terracina), 1911 and 1913*

Series	Date	Local mean time		Hor. int. obtained[1]		C.I.W.—Rome	Remarks
		From	To	C.I.W.	Rome		
	1911	h m	h m	γ	γ	γ	
I	Oct. 20	14 20	15 18	23819	23811	+8	C. I. W. magnetometer 7 at B, Rome magnetometer at A.
	20	15 33	16 10	817	808	+9	
	Mean	.		.		+8.5	
	1913						
II	Nov. 12	13 58	16 43	833	821	+12	C. I. W. 10 at B, Rome at A.
	13	14 21	16 44	831	819	+12	C. I. W. 10 at A, Rome at B.
	Mean	. . . .	.	. .	. . .	+12.0	
Mean value of (C. I. W.—Rome) from I and II . . .						+10.2γ or +0.00043H	

[1]All values are referred to A, $A=B+0.0\gamma$.

[1]Director Palazzo states in his letter of September 16, 1913, that he found it necessary to have all the axles of the needles of dip circle No. 51 renewed in 1912 by Dover.

TABLE 22 C.—*Results of Inclination Comparisons at Rome (Terracina), 1911 and 1913.*

Series	Date	Local mean time		Needles used		Inclination obtained[1]		C I W − Rome	Remarks
		From	To	C I W	Rome	C I W	Rome		
	1911	h m	h m			° ′	° ′	′	
I	Oct 21	10 04	11 11	1, 2	1, 2	+56 42.4	+56 43.6	−1.2	C. I. W at *B*, Rome at *A*
	21	14 58	15 58	1, 2	1, 2	44.0	45.0	−1.0	C. I W. at *A*, Rome at *B*
Mean value of (C I W.—Rome 1911, needles 1 and 2)								−1.1	
	1913								
II	Nov 15	8 59	10 41	1, 2, 5, 7	1, 2	+56 43.4	+56 44.2	−0.8	C I W. at *A*, Rome at *B*.
	15	10 43	12 17	1, 2, 5, 7	5, 6	42.9	44.0	−1.1	
	16	8 02	9 24	1, 2, 5, 7	15, 16	42.6	45.0	−2.4	
	16	14 11	15 37	1, 2, 5, 7	15, 16	42.6	44.8	−2.2	C. I. W. at *B*, Rome at *A*.
	16	15 41	16 29	5, 7	5, 6	42.7	43.6	−0.9	
	17	7 40	9 02	1, 2, 5, 7	1, 2	42.8	43.5	−0.7	
Mean value of (C. I. W —Rome 1913, needles 1 and 2)								−0.8	
Mean value of (C. I. W —Rome 1913, needles 5 and 6)								−1.0	
Mean value of (C. I. W.—Rome 1913, needles 15 and 16)								−2.3	

[1]All results are referred to *A*; $A = B - 0'.3$.

Referring the mean results to I. M. S. (see p. 273), we obtain:

(22) I. M. S.—Rome (Dover magnetometer No. 122) = $+0'.1$ (1911–13).

(22*a*) I. M. S.—Rome (Dover magnetometer No. 122) = $+0.00028H$ (1911–13).

(22*b*) I. M. S.—Rome (Dover dip circle No. 51, needles 1, 2) = $-0'.4$ (1911–13).

No. 23.—SAMOA OBSERVATORY, AT APIA, UPOLO.

The comparisons at the Samoa Geophysical Observatory were made in May 1906 by the *Galilee* party, using the regular observing-pier in the old absolute house. The instruments used by the *Galilee* observers were C. & G. S. magnetometer No. 36 and Dover dip circle No. 171. Some dip observations were also made for the Department of Terrestrial Magnetism by Mr. G. Heimbrod in December 1906, he likewise using Dover dip circle No. 171. The absolute instruments of the Observatory were in 1906: for declination and horizontal intensity, Tesdorpf magnetometer No. 1975, the constants of which were obtained by repeated comparisons with the Potsdam Observatory before and after 1906, so that the observations with No. 1975 may be regarded practically as referred to the Potsdam standard; for inclination, a Schulze earth inductor was used. Subsequent to 1906 or 1907, Tesdorpf magnetometer No. 2025 was the Observatory absolute instrument, and was referred to Potsdam by repeated comparisons of No. 2025 with No. 1975. In the publication[1] of Observatory results, 1905–1908, No. 2025 is called "Stations-theodolith," and No. 1975, "Anschluss-theodolith." Doctors Linke and Angenheister state[2] that No. 2025 gives too high east declinations by about 1′, and that the Schulze earth inductor showed no difference on the Potsdam standard; it is furthermore stated that the published declinations were all referred finally to Tesdorpf magnetometer No. 2025[3] (presumably corrected in accordance with the Potsdam comparisons).

It appears that, in 1906, there was, for magnetic inclination, at the point of observation, some local disturbance, which, according to information received from Dr. Angenheister, was such as to diminish numerically negative values of dip by about 3′ to 4′; the *Galilee* values obtained with Dover dip circle No. 171 have been corrected accordingly by 3′.5, it being assumed that the Observatory values were similarly corrected. Several other stations were occupied within the Observatory inclosure during May 1906, but, unfortu-

[1]Ergebnisse der Arbeiten des Samoa-Observatoriums der königlichen Gesellschaft der Wissenschaften zu Göttingen. V. Die erdmagnetischen Registrierungen der Jahre 1905 bis 1908, von F. Linke und G. Angenheister

[2]*Terr. Mag*, vol 15, p. 170

[3]This instrument was courteously loaned by the Samoa Observatory for the field work by Mr G. Heimbrod, temporarily connected with the Department of Terrestrial Magnetism in 1906

nately, there was no exchange of stations to determine station-differences, as it was reported by the Observatory that no local disturbance existed in the immediate neighborhood of the station; subsequent examination, however, showed that such disturbance did exist, and it is, therefore, not possible to utilize all the observations.

The *Galilee* party on the third cruise during March 1907, again made observations, without exchange of stations, at several stations within the Observatory inclosure, but could not occupy the absolute station, as at that time the old absolute house was being replaced by a new one. In addition to the unsuspected local disturbance, as reported after the first visit in May 1906, there seem to have been at this time other disturbances due to the building operations.

TABLE 23 A.—*Results of Declination Comparisons at the Samoa Observatory, 1906*

Date	Local mean time		Declination obtained		C.I.W. − Samoa	Remarks
	From	To	C.I.W.	Samoa		
1906	h m	h m	° ′	° ′	′	
May 3	8 29	8 38	+9 36 7	+9 35 9	+0 8	Samoa values pertain to magnetometer 1975.
3	10 28	10 37	36 3	34 9	+1 4	
Mean value of (C. I. W. − Samoa 1975)					+1 1	

TABLE 23 B.—*Results of Horizontal-Intensity Comparisons at the Samoa Observatory, 1906.*

Date	Local mean time		Hor. int. obtained		C.I.W. − Samoa	Remarks
	From	To	C.I.W.	Samoa		
1906	h m	h m	γ	γ	γ	
May 3	8 42	9 29	35692	35681	+11	Samoa magnetometer 1975 standardized at Potsdam
3	9 34	10 18	707	685	+22	
Mean value of (C. I. W. − Samoa 1975)					+16 5γ or +0 00046*H*	

TABLE 23 C.—*Results of Inclination Comparisons at the Samoa Observatory, 1906.*

Series	Date	Local mean time		Needles used with D C 171	Inclination obtained		C.I.W. − Samoa	Remarks
		From	To		C.I.W.	Samoa		
	1906	h m	h m		° ′	° ′	′	
I	May 3	16 43	17 21	1 and 2	−29 15 2	−29 14 6	−0 6	
	4	7 50	8 35		13 0	14 1	+1 1	
	8	8 59	10 00		11 7	(13 3)	+1 6	Weight, 0 5.
	Mean						+0 5	
II	Dec. 8	13 17	14 04	5 and 6 of 172	−29 20 3	−29 21 1	+0 8	
	9	9 53	10 37		19 1	20 4	+1 3	
	10	11 14	12 03		17 3	18 2	+0 9	
	13	10 22	11 07		17 3	17 3	0 0	
	Mean						+0 8	
Weighted mean value of (C. I. W. − Samoa) from I and II							+0 6	

The inclination results just given, on account of the local disturbance stated above, are not of sufficient accuracy to serve more than as a control on the corrections of dip circle No. 171.

The declination results, as well as those from the horizontal intensity comparisons, because of their meagerness, are to be regarded only as approximate quantities; if they are referred to I. M. S. (see p. 273), we obtain:

(23) I. M. S. – Samoa (Tesdorpf magnetometer No. 1975) = $+1'$ (1906).

(23a) I. M. S. – Samoa (Tesdorpf magnetometer No. 1975) = $+0.0003H$ (1906).

Attention must again be called to the fact that Tesdorpf magnetometer No. 1975 was replaced after 1906 by Tesdorpf magnetometer No. 2025.

No. 24.—TASHKENT OBSERVATORY, ASIATIC RUSSIA.

Comparisons were made at the Tashkent Observatory by Observer J. C. Pearson, in the course of his field work, September 3–6, 1909, but the Observatory data have not yet been received.

No. 25.—TIFLIS OBSERVATORY, KARSANI, EUROPEAN RUSSIA.

Comparisons were obtained at the Tiflis Observatory by Observer J. C. Pearson in June 1908 and again in June–July 1909, before and after extensive field work. In 1905 this Observatory, on account of disturbance from electric car lines, was removed from Tiflis to Karsani, in the mountains, near the village of Mtskhet, on the Batum-Tiflis railway and about 20 kilometers north of Tiflis.

In 1908 the comparisons were made as follows: On June 8 simultaneous sets of declination, inclination, and horizontal intensity were obtained, Mr. Rosenthal, of the Observatory, observing in the absolute house (A) and Mr. Pearson on a wooden pier (P) distant about 350 yards (320 meters) east of and below the absolute house. Mr. Pearson placed the tripod of his instrument centrally over P and mounted his magnetometer (C. I. W. No. 5) on this tripod. The two observers could not exchange stations owing to the non-portability of the Observatory instruments, which consisted of a Wild-Edelmann theodolite magnetometer and earth inductor. The existence of a slight local disturbance in this region produced, according to information supplied by Director Hlasek, the following station-differences: for declination, $A-P=+0'.9$, and for inclination, $A-P=-1'.7$. For horizontal intensity, the station-difference had not been definitely determined at the time; for the single observation here involved, namely, on June 8, it was assumed zero.

Accordingly Mr. Pearson made his subsequent observations in the absolute house. This house contains two stone piers about 30 inches (76 cm.) apart; on the southern one (A_s) is placed the Wild-Edelmann magnetometer (for declination and deflection observations), and on the northern one (A_n) the magnet house (with suspension tube) is mounted for oscillation observations. Mr. Pearson was obliged to use the latter pier (A_n) and it had to be assumed that the station-difference between the two piers, A_n and A_s, is zero. The Observatory results for declination apply strictly to pier A_s, whereas those for horizontal intensity refer to a mean position of A_s and A_n. While Mr. Pearson occupied A_n, the magnet house with suspension tube of the Observatory magnetometer was removed.

The Observatory mark could not be used by Mr. Pearson in the declination work at the pier A_n, and, accordingly, he was obliged to use a new mark, the azimuth of which was determined by him as follows:

1. June 9, 10, 1908, from Polaris observations	229° 26′.5 W. of S.
2. July 2, 3, 1909, from Sun observations	26 0
3. July 1909 by transfer from Observatory mark and azimuth . . .	26.0
Adopted	229° 26′.2

Mr. Pearson made his inclination observations, using Dover dip circle No. 177 (needles 1, 2, 5, and 6), at P on June 8, and thereafter at A_n. It is assumed that the Observatory observations for inclination all apply to A_s.

With the exception of the directly-observed quantities on June 8, the Observatory values are those derived from the magnetograph as furnished by Director Hlasek, November 11, 1908. All the values in the tables below apply to the absolute house (A). Mr. Pearson's observed values at P on June 8 were referred to the absolute house (A), with the aid of the station-differences given above.

Unfortunately the present results can not be controlled by those from the 1909 comparisons as the Observatory data for 1909 have not been supplied as yet.

TABLE 25 A.—*Results of Declination Comparisons at the Tiflis Observatory, 1908*

Date	Local mean time		Declination obtained		C.I.W.—Tiflis
	From	To	C.I.W.	Tiflis	
1908	h m	h m	° ′	° ′	′
June 8	15 26	15 35	+2 36 2	+2 35 5	+0 7
8	17 00	17 09	37 3	36 6	+0 7
9	9 24	9 33	44 0	41 5	+2 5
9	10 58	11 07	41 7	39 2	+2 5
9	11 26	11 35	41 3	38 8	+2 5
9	14 59	15 08	36 6	35 7	+0 9
10	14 31	14 40	35 7	34 3	+1 4
10	16 02	16 11	37.1	35 9	+1 2
10	16 34	16 43	38 0	36 9	+1 1
10	18 00	18 06	39 0	36 8	+2 2
11	8 09	8 18	43 5	42 9	+0 6
11	9 56	10 05	41 1	40 3	+0 8
11	10 32	10 41	39 8	38 9	+0 9
11	11 44	11 53	37 1	36 3	+0 8
Mean value of (C. I. W.—Tiflis). .					+1 3

TABLE 25 B —*Results of Horizontal-Intensity Comparisons at the Tiflis Observatory, 1908.*

Date	Local mean time		Hor int. obtained		C I.W.—Tiflis
	From	To	C I W.	Tiflis	
1908	h m	h m	γ	γ	γ
June 8	15 39	16 56	25418	25407	+11
9	9 39	10 53	408	402	+ 6
9	11 38	14 55	432	418	+14
10	14 44	15 59	439	426	+13
10	16 56	17 58	436	418	+18
11	8 21	9 54	404	396	+ 8
11	10 43	11 42	417	408	+ 9
Mean value of (C I. W.—Tiflis) .					+11 3γ or + 0 00045H

TABLE 25 C.—*Results of Inclination Comparisons at the Tiflis Observatory, 1908.*

Date	Local mean time		Inclination obtained		C I W.—Tiflis
	From	To	C.I W.	Tiflis	
1908	h m	h m	° ′	° ′	′
June 8	17 50	18 40	+56 27 6	+56 29 0	−1 4
9	16 03	17 47	25 2	26 3	−1 1
10	8 29	10 16	27 5	28 6	−1 1
10	10 54	12 34	26 2	27 2	−1 0
11	14 36	16 15	24 9	26 2	−1 3
Mean value of (C. I. W.—Tiflis).					−1 2

Referring the mean results in Tables 25 A, 25 B, and 25 C to I. M. S. (see p. 273), we obtain the following values of the quantity (I. M. S. − Tiflis): +1′.2 (for declination), +0.00030*H* (for horizontal intensity), and −0′.7 (for inclination). From S. Savinov's comparisons in December 1907 at Tiflis (see Table 31 A, p. 270), which unfortunately did not include declination observations, we derived (Table *B*, p. 278) for the value of (I. M. S. − Tiflis), +0.00031*H* (for horizontal intensity) and +0′.1 (for inclination). The agreement in the two independently-derived values (+0.00030*H* and +0.00031*H*) for the *H*-difference is very satisfactory. The two values (−0′.7 and +0′.1) for the *I*-difference, however, do not agree as well as is desirable.

Pending the receipt of the Observatory data for our 1909 comparisons, which were obtained under better conditions than in 1908, we defer giving our final results at Tiflis.

No. 26.—TOKIO OBSERVATORY, JAPAN.

Comparisons were secured with the standard magnetic instruments of the Central Meteorological Observatory at stations in the grounds of the Tokio University during August and September 1906, when the magnetic survey vessel, *Galilee*, was at Yokohama. The instruments used by the members of the *Galilee* party were C. & G. S.[1] magnetometer No. 36 and C. & G. S. dip circles No. 35 (with needles 2 of circle 35 and 5 of circle 163) and Dover No. 178 (with needles 1, 2, 5, and 6). The observations with the Tokio instruments were made by Messrs. S. Nakamura and Y. Oishi, under the direction of Professor Tanakadate. The Tokio instrument used for declination and horizontal intensity was of the pattern of magnetometer devised by Professor Tanakadate and described in the Journal of Science, Imperial University, Japan (Vol. II, Part III). For inclination, the Tokio standard, a Casella dip circle (No. 17?), and a Wild earth inductor were used.

All the Tokio observations were obtained in the absolute house of the Observatory, while most of the C. I. W. observations were made at the main C. I. W. station about 30 feet north of the absolute house; some dip observations also were secured by the *Galilee* party at a secondary station located about 30 feet west of the main C. I. W. station. The stations outside the absolute house were selected after consultation with Professor Tanakadate; the station-differences were not determined, as it was understood that they were negligible. The observations by the two observing parties were not always strictly simultaneous, and it was necessary, therefore, in reducing the two series to equivalent local mean times, to make use of copies of the declination magnetograms and of the published hourly results of hortizonal and of vertical intensity.

Subsequent to the work of August 15 and 16, 1906, the C. & G. S. magnetometer No. 36 suffered to some extent by having been submerged in its box during the accident which befell the *Galilee* in Yokohama Bay owing to a typhoon. The work of September 3, 1906, was carried out after the instrument had been thoroughly cleaned.

The azimuth of mark (lightning-conductor on Chemical Laboratory) was, as supplied by Professor Tanakadate, 179° 55′.4 from the absolute house, and 179° 54′.6 from the main C. I. W. station.

In view of the non-exchange of stations, lack of simultaneity of observations, unequal number of determinations by the two parties, and the uncertainties involved in the reductions to the same times and to the C. I. W. standards, the results of the comparisons should be regarded as wholly tentative ones. It is hoped in the near future to obtain better determinations of the relations between the Tokio and the C. I. W. standards.

[1] C & G S stands for United States Coast and Geodetic Survey.

The mean results obtained from these *approximate* comparisons, after reducing them to I. M. S. (see p. 273), are:

(26) I. M. S.–Tokio (Observatory Tanakadate magnetometer) = +0'.6 (6 sets; Aug. 15, 16, Sept. 3, 1906).

(26*a*) I. M. S.–Tokio (Observatory Tanakadate magnetometer) = +0.00048*H* (3 sets; Aug. 15, 16, Sept. 3, 1906).

(26*b*) I. M. S.–Tokio (Observatory Casella dip circle) = –3'.2 (5 sets; Aug. 15, 16, 1906).

(26*c*) I. M. S.–Tokio (Wild earth inductor) = +4'.5 (5 sets; Aug. 15, 16, 1906).

The following data will afford some idea of the possible corrections of one of the standard sets of instruments used in the 1895 magnetic survey of Japan, namely, Tanakadate magnetometer No. 3, and Casella dip circle No. 5615, needle 1. Comparisons were made at Tokio on August 9–11, 1898, between these instruments and those of the Austrian naval vessel, the *Frundsberg*.[1] With the aid of the standardizations of the latter instruments, made at Pola in April 1898 and July 1899, the following figures[2] result, if we also take into consideration the 1895 *D* and *H* comparisons at Tokio, obtained by Karl Kailer of the Austrian Navy, giving them, however, half weight, as they were fewer in number than those of the *Frundsberg:*

(*a*) Pola (Schneider magnetometer)–Tokio (Tanakadate magnetometer No. 3) = –1'.8 (1895 and 1898).

(*b*) Pola (Schneider magnetometer)–Tokio (Tanakadate magnetometer No. 3) = +0.00079*H* (1895 and 1898).

(*c*) Pola (Wild inductor)–Tokio (Casella No. 5615, needle 1) = –4'.2 (1898).

From comparisons[3] at the Pola Observatory, December 1902–January 1903, the following relations were found between the new Pola magnetometer (Bamberg No. 7904) and the Schneider magnetometer formerly in use:

(*d*) Pola (Bamberg No. 7904)–Pola (Schneider) = –0'.6 (6 sets; Jan. 1903).

(*e*) Pola (Bamberg No. 7904)–Pola (Schneider) = –0 00046*H* (6 sets; Dec. 1902).

Combining (*a*) and (*b*) with (*d*) and (*e*):

(*f*) Pola (Bamberg No. 7904)–Tokio (Tanakadate magnetometer No. 3) = –2'.4 (1895–1903).

(*g*) Pola (Bamberg No. 7904)–Tokio (Tanakadate magnetometer No. 3) = +0.00033*H* (1895–1902).

With the aid of the C. I. W. comparisons at Pola in 1910 (Tables 18 A, 18 B, 18 C, p. 248) we get, from (*f*), (*g*), and (*c*), *assuming* no material changes in instrumental constants between 1895 and 1910:

(*h*) C. I. W.–Tokio (Tanakadate magnetometer No. 3) = –2'.7 (1895, 1898, 1902, 1910)

(*i*) C. I. W.–Tokio (Tanakadate magnetometer No. 3) = +0.00087*H* (1895, 1898, 1902, 1910).

(*j*) C. I. W.–Tokio (Casella 5615, needle 1) = –4'.1 (1898, 1910).

In these comparisons at Tokio in 1895 and 1898, the observations were made in two tents, distant from each other about 30 steps, in the recreation grounds in front of the Physical Institute of the University. As the observers did not exchange stations, possible station-differences were not eliminated.

Reducing to I. M. S. by applying to the C. I. W. values in (*h*), (*i*), and (*j*) the corrections stated on p. 273, we get as *approximate* results:

(26*d*) I. M. S.–Tokio (Tanakadate magnetometer No. 3) = –2'.6 (1898).

(26*e*) I. M. S.–Tokio (Tanakadate magnetometer No. 3) = +0.00072*H* (1898).

(26*f*) I. M. S.–Tokio (Casella 5615, needle 1) = –3'.6 (1898).

In view of the uncertainties attaching to the results of the above comparisons, they are not entered in Table A, page 278.

[1]*Terr. Mag*, v. 7, 1902, p. 196.

[2]The signs of the declination corrections were reversed so as to apply to east declination positive

[3]Jahrbuch der meteorolog., erdmagnet. und seismischen Beobachtungen, 1902, pp. XXXIX–XLII, Pola 1903.

No. 27.—WASHINGTON, D. C. (DEPARTMENT OF TERRESTRIAL MAGNETISM).

A very large number of comparisons and experiments has been made by the Department of Terrestrial Magnetism at Washington, District of Columbia, since its establishment on April 1, 1904. During the period 1905–13, the observations were made chiefly in two small non-magnetic huts built on a bluff overlooking the Zoological Park, in close proximity to the quarters in the Ontario Apartment House first occupied by the Department. However, since the purchase of the present site in 1913 and the erection of special buildings during 1913–14, exceptional facilities are possessed by the Department for standardizing magnetic instruments and for carrying out the various experimental problems ensuing from such work. The present site of the headquarters of the Department of Terrestrial Magnetism is one singularly free from the local magnetic disturbances so prevalent in the city of Washington and vicinity. (Fig. 4, Plate 13, shows a rear view of the 3 observing houses.)

The following specimen comparisons (Tables Nos. 27 A, 27 B) between C. I. W. magnetometers Nos. 3 and 5 at Washington in 1907–08 will be of interest in view of the fact that magnetometer No. 5 was used as the intermediary instrument for obtaining comparisons in 1908–10 between the C. I. W. standards and those at Helwan, Kew, Pola, Potsdam, and Tiflis. (See also Tables 30 A, 30 B, 30 C, 30 D, pp. 268–269.)

TABLE 27 A.—*Results of Declination Comparisons at Washington, 1907–08.*

Series	Date	Local mean time		Declination obtained[1]		C. I. W. – C. I. W. 5	Remarks
		From	To	C. I. W.[2]	C. I. W. 5		
	1907	h m	h m	° ′	° ′	′	
I	Dec. 20	14 18	14 27	–4 44.7	–4 44.6	–0.1	Magnetometer 3 at C_m; magnetometer 5 at A_m.
	20	14 40	14 50	43.8	43.4	–0.4	
	20	15 22	15 31	42.7	42.7	0.0	
	20	15 38	15 47	42.1	42.5	+0.4	
	20	16 07	16 16	41.4	42.0	+0.6	
	21	13 58	14 07	43.9	44.0	+0.1	
	24	10 08	10 17	40.9	40.8	–0.1	Magnetometer 3 at A_m; magnetometer 5 at C_m
	24	10 25	10 34	41.4	41.3	–0.1	
	24	10 51	11 00	41.5	42.0	+0.5	
	24	11 05	11 14	42.3	42.1	–0.2	
	24	11 35	11 44	44.1	44.1	0.0	
Mean						+0.06	
	1908						
II	Feb. 12	10 04	10 13	38.5	38.6	+0.1	Magnetometer 3 at A_m; magnetometer 5 at C_m
	12	12 15	12 24	42.7	43.0	+0.3	
	12	13 18	13 27	44.0	44.0	0.0	
	12	15 20	15 29	43.6	44.0	+0.4	
	14	10 15	10 24	38.9	38.5	–0.4	Magnetometer 3 at C_m, magnetometer 5 at A_m.
	14	12 27	12 36	42.6	43.0	+0.4	
	14	13 31	13 40	44.7	45.0	+0.3	
	14	15 33	15 42	44.5	44.9	+0.4	
Mean						+0.19	
Mean value of (C. I. W. – C. I. W. 5), Series I and II						+0.12	

[1]All values are referred to station A_m; $A_m = C_m + 17.'9$ (series I), $A_m = C_m + 19'.2$ (series II)
[2]These are the values obtained with C. I. W. No. 3 standardized.

TABLE 27 B.—*Results of Horizontal-Intensity Comparisons at Washington, 1908.*

Date	Local mean time		Hor int obtained[1]		C. I. W.—C I. W. 5	Remarks
	From	To	C I. W.[2]	C. I W. 5		
1908	h m	h m	γ	γ	γ	
Feb. 12	10 22	11 20	19931	19948	−17	Magnetometer 3 at A_m; magnetometer 5 at C_m.
12	11 27	12 12	921	939	−18	
12	13 32	14 21	925	942	−17	
12	14 26	15 16	938	954	−16	
14	10 23	11 24	913	941	−28	Magnetometer 3 at C_m, magnetometer 5 at A_m
14	11 29	12 15	911	928	−17	
14	13 39	14 28	916	929	−13	
14	14 37	15 21	929	937	− 8	
Mean value of (C. I W —C I. W. 5)					−16 8γ or −0 00084H	

[1]All values are referred to station A_m, $A_m = C_m + 39\gamma$

[2]These are the values obtained with C I W No. 3 standardized The three deflection distances 25, 30, and 40 cms. were used for each instrument.

The next series of comparisons will serve further to show the accuracy attainable in such work with field instruments. Magnetometer C. I. W. No. 15 of the type 1 (*b*), described and illustrated in Volume I, pp. 2–7, and Plate 3, Fig. 2, was designed and constructed in 1910 by the Department of Terrestrial Magnetism for the Meteorological Service of Canada, the present owner of the instrument. After all the constants had been carefully determined, by the Department of Terrestrial Magnetism, the magnetometer was compared at Washington with C. I. W. No. 3. This magnetometer (C. I. W. No. 15) has figured in the comparisons at the Agincourt Observatory (see Table 1 B, series V, p. 215).

It will be seen that the H-results with C. I. W. No. 15 are given separately for the 3 deflection distances, $r=20$ cms., $r=25$ cms., and $r=28$ cms.

TABLE 27 C.—*Results of Declination Comparisons between C I. W Magnetometers Nos. 3 and 15 at Washington*

Date	Local mean time		Declination obtained[1]		C. I. W.—C.I.W. 15	Remarks
	From	To	C. I W[2]	C.I W. 15		
1910	h m	h m	° ′	° ′	′	
Feb. 28	13 28	13 37	−4 55 0	−4 55 8	+0 8	No 3 at A_m, No. 15 at C_m.
28	15 20	15 29	54 1	53 8	−0 3	
28	15 44	15 52	53 9	54 2	+0 3	
Mar 1	10 54	11 03	52 1	52 3	+0 2	
1	11 13	11 22	52 6	52 2	−0 4	
1	13 20	13 29	53 7	53 9	+0 2	
1	13 54	14 03	54 4	55 0	+0 6	No 3 at C_m; No. 15 at A_m.
1	15 34	15 43	56.1	55 9	−0 2	
1	15 56	16 05	55 9	56 2	+0 3	
2	10 43	10 52	51 1	51.5	+0 4	
2	11 02	11 11	52 5	52 7	+0 2	
2	13 07	13 19	53 1	52 7	−0 4	
Mean value of (C I W — C. I W. No 15)					+0.14	

[1]All values are referred to station A_m; $A_m = C_m + 19' 8$.

[2]These are the values obtained with C I W. No. 3 standardized.

TABLE 27 D.—*Results of Horizontal-Intensity Comparisons between C. I. W. Magnetometers Nos 3 and 15 at Washington*

Date	Local mean time		Horizontal intensity obtained[1]				C I W − No 15		
	From	To	C. I W.[2]	C. I. W 15			r=20 cm	r=25 cm.	r=28 cm
				r=20 cm	r=25 cm	r=28 cm			
1910	h m	h m	γ	γ	γ	γ	γ	γ	γ
Feb. 28	13 49	15 16	19826	19814	19816	19818	+12	+10	+ 8
Mar 1	9 23	10 50	820	820	818	818	0	2	2
1	11 25	13 17	814	804	802	806	10	12	8
1	14 05	15 30	814	812	811	813	2	3	1
2	9 18	10 40	836	827	827	824	9	9	12
2	11 13	13 04	826	818	820	813	8	6	13
Mean value of (C. I W.−C I. W. No 15)							+ 6 8	+ 7 0	+ 7 3

[1]All values are referred to station A_m; $A_m = C_m + 30\gamma$.
[2]These are the values obtained with C I W. No. 3 standardized.

The following special results of earth-inductor comparisons will be of interest, as No. 4 was installed at the Mauritius Observatory in 1913.

TABLE 27 E.—*Results of Comparisons at Washington in 1913 between Schulze Earth Inductor No. 48 and C. I W. Earth Inductor No. 4, Constructed for the Mauritius Observatory.*

(Method of alternate comparisons, using 2 stations, A and C, and exchanging stations in middle of series; observer, H. W. F)

Date	Local mean time		Inclination obtained[1]		Schulze 48—E. I. No. 4	Remarks
	From	To	Schulze 48	E. I. No 4		
1913	h m	h m	° ′	° ′	′	
Jan. 15	9 52	10 21		+70 55 7		No. 48 at A, No. 4 at C
15	11 26	12 00	+70 55 9			
15	13 10	13 37	55 4		+0 1	
15	14 05	14 30		55 4		
15	14 37	15 13		54.1		
15	15 24	15 52	54 3			
15	15 57	16 15	54 2		+0 4	
15	16 19	16 41		53 5		
16	10 42	11 01	56.2			No 48 at C; No. 4 at A
16	11 18	11 37		56 0		
16	11 40	12 04		55 7	+0 4	
16	12 11	12 26	56 2			
16	13 37	13 57	54 9			
16	14 14	14 40		54.6		
16	14 49	15 04		54 5	+0 2	
16	15 13	15 30	54 6			
Mean value of (Schulze No. 48−C I.W No. 4) .					+0 3	

[1]All results are referred to station C, $C = A + 1' 0$, the values with No 48 are as observed, i e, without any correction applied, hence being practically I M. S values (see p 273)

NOS. 28 AND 29.—ZIKAWEI AND LUKIAPANG OBSERVATORIES, CHINA.

Both series of comparisons at the Zikawei Observatory in 1907 were made in the absolute house (H) of the Observatory and at a second station (N), distant 21.3 meters in a direction 6° west of north from the pier in the absolute house. Series I was obtained at the time of the visit of the *Galilee* in May 1907 to Shanghai; series II was obtained by Dr. C. K. Edmunds, associated with the Department of Terrestrial Magnetism.

The standard instruments of the Observatory were: Elliott magnetometer No. 49 and Dover dip circle No. 33 (needle 14). The C. I. W. instruments used were: for series I, C. I. W. magnetometer No. 1 and Dover dip circle No. 178 (needles 1 and 2); for series II, C. I. W. magnetometer No. 2.

TABLE 28 A.—*Results of Declination Comparisons at the Zikawei Observatory, 1907.*

Series	Date	Local mean time		Declination obtained[1]		C. I. W. − Zikawei	Remarks
		From	To	C. I. W.	Zikawei		
	1907	h m	h m	° ′	° ′	′	
I	May 14	10 03	10 12	−2 32 9	−2 32 0	−0 9	C. I. W. magnetometer 1 at N, Elliott 49 at H.
	14	11 29	11 38	35 5	35 4	−0 1	
	15	10 44	10 54	35 6	34 1	−1 5	
	15	11 56	12 05	38 3	36 6	−1 7	C. I. W. magnetometer 1 at H; Elliott 49 at N.
	14	13 57	14 07	37 5	36 2	−1 3	
	14	15 18	15 27	35 6	35 1	−0 5	
	Mean					−1 0	
II	Sept 11	15 01	15 14	−2 36 1	−2 35 2	−0 9	C. I. W. magnetometer 2 at N
	11	17 28	17 38	35 2	34 5	−0 7	
	12	15 00	15 13	36 5	35 3	−1 2	
	12	9 39	9 50	36 3	34 8	−1 5	C. I. W. magnetometer 2 at H
	12	12 04	12 16	38 3	37 4	−0 9	
	Mean					−1 0	
Mean value of (C. I. W. − Zikawei) from I and II						−1 0	

[1]All values are referred to H; $H = N + 1'4$

TABLE 28 B.—*Results of Horizontal-Intensity Comparisons at the Zikawei Observatory, 1907*

Series	Date	Local mean time		Hor. int. obtained[1]		C. I. W. − Zikawei	Remarks
		From	To	C. I. W.	Zikawei		
	1907	h m	h m	γ	γ	γ	
I	May 14	10 20	11 20	33034	32997	+37	C. I. W. 1 at N, Elliott 49 at H
	14	14 12	15 12	3087	3061	+26	C. I. W. 1 at H, Elliott 49 at N.
	15	10 55	11 54	3081	3071	+10	C. I. W. 1 at N, Elliott 49 at H
	Mean					+24 3	(weight, 1 0)
II	Sept 11	11 28	12 30	33099	33073	+26[2]	C. I. W. 2 at N.
	11	15 16	17 22	3056	3044	+12[3]	
	12	15 17	17 28	3014	2998	+16	
	12	9 56	12 00	3022	3006	+16[3]	C. I. W. 2 at H.
	Weighted mean					+16 2	(weight, 2 0)
Weighted mean value of (C. I. W. − Zikawei) from I and II						+18 9γ or +0 00057H.	

[1]All values are referred to H, $H = N - 14\gamma$. [2]Quarter set; weight, 0 25 [3]Half set, weight, 0 5

TABLE 28 C.—*Results of Inclination Comparisons at the Zikawei Observatory, 1907*

Date	Local mean time		Inclination obtained[1]		C. I. W. − Zikawei	Remarks.
	From	To	C. I. W.	Zikawei		
1907	h m	h m	° ′	° ′	′	
May 14	16 00	16 46	+45 39.0	+45 40 9	−1 9	D. C. 178 at N, D. C. 33 at H
18	11 03	11 29	37 2	37 0	+0 2	D. C. 178 at H, D. C. 33 at N
18	8 56	9 33	36 9	37 8	−0 9	
Mean value of (C. I. W. − Zikawei)					−0 9	

[1]All results are referred to H, $H=N+0'4$

The method of comparison for series I was that of simultaneous observations and exchange of stations. For series II, the Observatory data were derived from the magnetograms as standardized by the Observatory instruments mentioned above. The dip observations in September 1907 were insufficient for comparisons.

The next comparisons (1911) were obtained by Dr. C. K. Edmunds, in connection with the magnetic survey of China, at the Lukiapang Observatory, which succeeded the Zikawei

Observatory in March 1908. The geographical position of Lukiapang Observatory is 31° 19′.05 north latitude, and 121° 02′.4 east of Greenwich.

The Observatory standards were: Elliott magnetometer No. 49 (same[1] as used in the previous comparisons at Zikawei) and Schulze earth inductor No. 42. The C. I. W. instruments used were: C. I. W. magnetometer No. 12 and Dover dip circle No. 206 (needles 1, 2 of No. 206, and needles 5, 6 of No. 178).

The stations occupied for D and H observations were the "Elliott Pillar" (D_a) in the absolute house (D), and "Edmunds Pillar" (F) in the grounds about 18 meters southwest of D_a. The same mark was used at both stations, viz, the regular Observatory mark on the south wall of the compound; the azimuth of this mark, as furnished by Reverend J. de Moidrey, at Pillar D_a is 3° 47′.0 west of south, and at Pillar F is 357° 08′.4 west of south. When either magnetometer is mounted at F, one footscrew is directly to the north; when mounted at D_a, however, one footscrew is to the south. The method of comparisons for D and H was that of simultaneous observations and exchange of stations. The H-values, as tabulated, are derived from 1 set of oscillations, 2 sets of deflections, and 1 set of oscillations. The Observatory values are the final ones communicated by the Reverend J. de Moidrey in his letter of October 3, 1914.

As it was not possible to move the Observatory earth inductor so as to afford an exchange of stations, the following method for the inclination comparisons was carried out in the absolute house: dip circle No. 206 was mounted on pillar b, 1 meter north of pillar c, on which earth inductor No. 42 is mounted; observations were made alternately with No. 42 and No. 206, the inductor-coils being stationary while No. 206 was in use and the needles of No. 206 being removed while No. 42 was observed with. A complete dip-comparison consisted of: (1) Observations with the earth inductor according to the usual method of the Observatory; (2) dip with one pair of needles of No. 206, ends "A" down; (3) earth inductor same as (1); (4) dip with second pair of needles of No. 206, ends "A" down;

TABLE 29 A.—*Results of Declination Comparisons at the Lukiapang Observatory, 1911*

Date	Local mean time		Declination obtained[1]		C. I. W. − Lukiapang	Remarks
	From	To	C. I. W.	Lukiapang		
1911	h m	h m	° ′	° ′	′	
Sept. 12	14 08	14 21	−3 06 8	−3 05 2	−1 6	C. I. W. magnetometer 12 at F; Elliott magnetometer 49 at D_a.
12	15 46	15 55	04 9	04 3	−0 6	
12	16 30	16 39	03 8	03 1	−0 7	
12	17 44	17 53	03 7	02.4	−1 3	
13	8 21	8 30	01 6	−2 59.2	−2 4	
13	9 39	9 48	02 6	−3 01 1	−1 5	
14	13 22	13 31	07 5	06 4	−1 1	C. I. W. magnetometer 12 at D_a; Elliott magnetometer 49 at F
14	14 35	14 44	07 3	05.4	−1 9	
14	15 11	15 18	06 6	04 6	−2 0	
14	16 26	16 35	04 5	03.1	−1 4	
14	16 43	16 50	03.7	02 8	−0 9	
14	16 54	17 01	03 8	02.4	−1 4	
Mean value of (C. I. W.—Lukiapang)				.	−1 4	

[1]All values are referred to station D_a; $D_a = F - 1'.0$.

(5) earth inductor same as (1); (6) second half of dip with second pair of needles of No. 206, ends "B" down; (7) earth inductor same as (1); (8) second half of dip with first pair of needles of No. 206, ends "B" down; (9) earth inductor same as (1); the mean of the earth-inductor observations (1), (3), (5), (7), and (9) thus corresponded in time with the mean of the dip-circle observations (2), (4), (6), and (8).

[1]Somewhat different values of the constants, for example of P, appear to have been used in 1911 from those in 1907.

TABLE 29 B.—*Results of Horizontal-Intensity Comparisons at the Lukiapang Observatory, 1911.*

Date	Local mean time		Hor. int. obtained[1]		C. I. W. − Lukiapang	Remarks
	From	To	C. I. W.	Lukiapang		
1911	h m	h m	γ	γ	γ	
Sept. 12	14 27	15 43	33271	33244	+27	C. I. W. magnetometer 12 at F, Elliott magnetometer 49 at D_a
12	16 44	17 41	268	230	+38	
13	8 33	9 36	236	202	+34	
13	10 56	11 56	251	218	+33	C. I. W. magnetometer 12 at D_a, Elliott magnetometer 49 at F.
14	13 32	14 33	264	246	+18	
14	15 23	16 21	282	234	+48	
Mean value of (C. I. W. − Lukiapang)					+33.0γ or +0.00099H.	

[1]All values are referred to D_a, $D_a = F - 8.5\gamma$.

TABLE 29 C.—*Results of Inclination Comparisons at the Lukiapang Observatory, 1911.*

Date	Local mean time		Inclination obtained		C. I. W. − Lukiapang	Remarks
	From	To	C. I. W.	Lukiapang		
1911	h m	h m	° ′	° ′	′	
Sept. 13	13 53	15 24	+45 33.1	+45 33.5	−0.4	C. I. W. dip circle 206 at D_b, Lukiapang earth inductor at D_c.
13	15 40	16 24	32.8	33.5	−0.7	
14	8 25	9 03				
14	9 18	11 11	32.9	33.4	−0.5	
Mean value of (C. I. W. − Lukiapang)					−0.5	

Assembling the results and referring them to I. M. S. (see p. 273), we obtain:

(28) I. M. S. − Zikawei (Elliott magnetometer No. 49) = −1′.1 (1907).
(28*a*) I. M. S. − Zikawei (Elliott magnetometer No. 49) = +0.00042H (1907).
(28*b*) I. M. S. − Zikawei (Dover dip circle No. 33, needle 14) = −0′.4 (1907).
(29) I. M. S. − Lukiapang (Elliott magnetometer No. 49) = −1′.5 (1911).
(29*a*) I. M. S. − Lukiapang (Elliott magnetometer No. 49) = +0.00084H (1911).
(29*b*) I. M. S. − Lukiapang (Schulze earth inductor No. 42) = 0′.0 (1911).

NO. 30.—SPECIMEN FIELD COMPARISONS.

The comparisons in 1910 at Rumeli Hissar, near Constantinople, by Observers J. C. Pearson and W. H. Sligh, will serve as a specimen of field comparisons such as the observers of the Department of Terrestrial Magnetism seek to obtain whenever opportunity affords. In this particular case Mr. Pearson was homeward bound after two years' field work and Mr. Sligh was sent to meet him at Constantinople, and after intercomparing instruments with him, to continue the magnetic survey in Turkish countries.

The instruments used by Mr. Pearson were C. I. W. magnetometer No. 5 and Dover dip circle No. 177 (needles 1, 2, 5, and 6), whereas Mr. Sligh observed with C. I. W. magnetometer No. 7 and Dover dip circle No. 202 (needles 1, 2, 5, and 6).

The comparisons were made at two stations, A and B, in the grounds of Robert College, about 6 miles northward from Constantinople. B is 88.5 feet south and 84.5 feet west of A. *Adverse weather conditions were experienced at the time of the comparisons, a continuous south wind, which at times came in very severe gusts, rendering observations in the observing tents very difficult.*

The method of comparisons was that of simultaneous observations and exchange of stations.

Since Mr. Pearson's instruments were used in comparisons with the magnetic standards at Kew in March 1908 and March 1910, at Helwan in April 1908, at Tiflis in June 1908 and July 1909, at Pola in February 1910, and at Potsdam in February 1910, it will be of interest to see what control the above field comparisons gave over the corrections of his instruments on the C. I. W. standards. (See Table 30 D.)

TABLE 30 A.—*Results of Declination Comparisons at Rumeli Hissar, Turkey, 1910.*

Date	Local mean time		Declination obtained[1]		C I W. 5—C I W. 7	Remarks
	From	To	C I W. 5	C I. W. 7		
1910	h m	h m	° ′	° ′	′	
Jan. 18	14 26	14 35	−2 11 4	−2 10 5	−0 9	Magnetometer 5 at *B*; magnetometer 7 at *A*.
18	16 18	16 27	10 0	10 7	+0 7	
21	9 48	9 57	07 9	07 7	−0.2	
21	11 38	11 47	10 5	11 0	+0 5	
21	12 08	12 17	11 1	11 5	+0 4	
21	14 16	14 25	10 9	11.2	+0 3	
21	14 40	14 49	11 7	11 4	−0 3	
21	16 33	16 42	09 8	09 4	−0 4	
26	9 53	10 02	09 5	09.4	−0 1	Magnetometer 5 at *A*, magnetometer 7 at *B*
26	11 39	11 48	13 0	12 8	−0 2	
26	12 03	12 12	11 1	11 0	−0.1	
26	14 03	14 12	13 0	12 8	−0 2	
26	14 23	14 32	12.2	12 8	+0 6	
26	16 03	16 12	10 5	10 2	−0.3	
Mean value of (C. I. W. 5—C. I. W. 7)					0 0	

Since C. I. W. = C. I. W. 7+0′ 1, we have C. I. W. = C. I W. 5+0′.1

[1]All values are referred to station *A*; *A*=*B*—0′ 6 They are not reduced, however, to C I. W. standard

TABLE 30 B.—*Results of Horizontal-Intensity Comparisons at Rumeli Hissar, Turkey, 1910*

Date	Local mean time		Hor int. obtained[1]		C. I. W. 5—C. I. W 7	Remarks
	From	To	C I. W 5	C. I. W 7		
1910	h m	h m	γ	γ	γ	
Jan. 18	14 41	16 13	25012	24993	+19	Magnetometer 5 at *B*, magnetometer 7 at *A*.
19	13 20	15 10	4974	4992	−18	
21	10 02	11 31	4977	4974	+ 3	
21	12 21	14 10	4989	4992	− 3	
21	14 53	16 27	5011	5006	+ 5	
26	10 05	11 35	4981	4975	+ 6	Magnetometer 5 at *A*; magnetometer 7 at *B*.
26	12 14	13 59	4966	4972	− 6	
26	14 36	15 57	4974	4969	+ 5	
Mean value of (C. I W. 5—C. I W 7)					+ 1 4γ or +0 00006*H*	

Since C. I. W.=C. I. W 7—0 00096*H*, we have C I. W.= C. I. W 5—0.00102*H*.

[1]All values are referred to station *A*, *A*=*B*—33γ. They are not reduced, however, to C. I. W. standard.

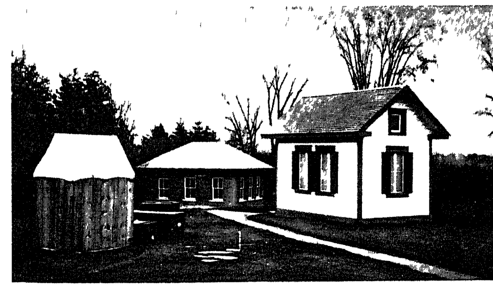
TABLE 30 C —*Results of Inclination Comparisons at Rumeli Hissar, Turkey, 1910.*

Date	Local mean time		Inclination obtained[1]		C.I W. 202—C I.W. 177	Remarks
	From	To	C I.W. 202	C.I W. 177		
1910	h m	h m	° ′	° ′	′	
Jan. 22	11 08	12 51	+55 13 8	+55 13 5	+0.3	D. C. 202 at *A*, D. C. 177 at *B*.
22	14 21	15 51	13 7	13 0	+0 7	
25	9 50	11 27	15.6	15 6	0.0	
25	12 32	14 30	17 9	17 2	+0 7	D. C. 202 at *B*, D C. 177 at *A*
25	15 07	16 35	18 3	18 2	+0.1	
27	10 16	11 58	14 0	13 7	+0 3	
Mean value of (C I. W. 202—C. I W. 177)					+0 4	

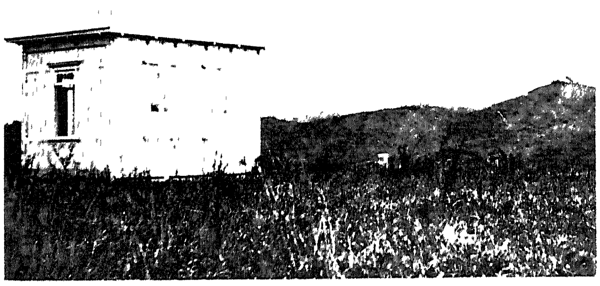
Since C I W.= C. I. W. 202—0′.2, we have, C. I. W.= C. I. W. 177+0′ 2.

[1]All values are referred to station *A*; *A*=*B*+1′.2 They are not reduced, however, to C. I. W. standard.

1



2



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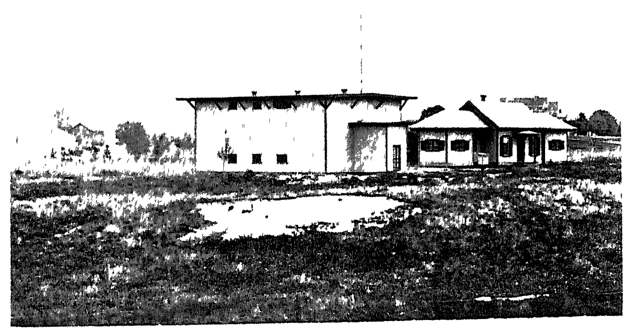

6

Views of Magnetic Observatories in North and South America.

1. Pilar, near Cordoba, Argentina.
2. Ottawa, Canada.
3. Vassouras, near Rio de Janeiro, Brazil
4. Department of Terrestrial Magnetism, Washington, D C
5. Vieques, Porto Rico
6. Cheltenham, Maryland

TABLE 30 D.—*Determination of Corrections of C. I. W. Magnetometer No. 5 and Dip Circle No. 177 (needles 1, 2, 5, 6).*

Compared at	Date	C. I. W.—Magnetometer No. 5				C. I. W.—D. C. 177.1256		
		ΔD	Weight	$\frac{\Delta H}{H}$	Weight	I	ΔI	Weight
		′				°	′	
Washington, D. C.	1907, Dec.	+0.2	1			+70.5	0.0	1
Washington, D. C.[1]	1908, Jan., Feb.	+0.1	1	−0.00084	2	+70.5	−0.3	2
Rumeli Hissar	1910, Jan.	+0.1	1	−0.00102	1	+55.3	+0.15	1
Washington, D. C.	1910, Mar., Apr.					+70.6	−0.8	2
Weighted means		+0.1		−0.00090		(Function of I)		

[1]See Tables 27 A, 27 B, pp. 262–263, giving results of comparisons at Washington.

The corrections accordingly adopted for C. I. W. magnetometer No. 5 for the observatory comparisons referred to, were $+0'.1$ for declination and $-0.00090H$ for horizontal intensity. The instrument unfortunately sustained a fall during the comparisons at Washington upon Mr. Pearson's return in 1910, necessitating extensive repairs and altering the constants. However, the various checks applied (see, for example, Table 30 D) show that, during the two years this instrument was used in field work of the most severe character, its constants remained unaltered within the errors of observation. See also the results of comparisons at the Kew Observatory (Tables 14 A, 14 B, p. 241), before and after this field work.

No. 31.—VARIOUS ADDITIONAL OBSERVATORIES.

During 1905–1907, comparisons were obtained by the observers of the Department of Terrestrial Magnetism at the following additional magnetic observatories: Baldwin (Kansas), Honolulu (Hawaii), and Sitka (Alaska). These observations were, however, primarily intended to serve as a control on the constants of the instruments used in the magnetic survey work (chiefly the work of the *Galilee* in the Pacific Ocean). It might also be remarked that the magnetic instruments at Baldwin, Honolulu, and Sitka are referred by the United States Coast and Geodetic Survey to the standards of the Cheltenham Magnetic Observatory, for which direct comparisons are given on pp. 226–229.

During the period 1907–10, two important series of comparisons at certain magnetic observatories in Europe and Asia were obtained by observers of other organizations, the results of which it will be desirable to include in this report.

TABLE 31 A.—*Preliminary Results of Comparisons between the Pavlovsk Magnetic Standards and Certain Observatory Standards*

[The following series of comparisons was made by the Russian observers, Messrs. W. Dubinsky and S. Savinov, in 1907–08, and referred by them to the magnetic standards (Declinometer, Wild-Freiberg magnetometer No. 1 and earth inductor) of the Pavlovsk Magnetic Observatory, near Petrograd. Their results as published in W. Dubinsky's preliminary report[1] have been modified here as follows: (*a*) the signs of the declination differences (ΔD) have been reversed in order to correspond with east declination taken as positive; (*b*) the horizontal-intensity differences (ΔH) have been expressed in parts of H with the aid of the approximate value of H at the observatory compared.]

No.	Observatory	Approximate		Date	Pavlovsk—Observatory			Pavlovsk Observer	Observatory Instruments[2]	
		Lat.	E. Long.		ΔD	$\frac{\Delta H}{H}$	ΔI		Magnetometer	Inclinometer
		°	°		′		′			
32	Irkutsk	52.3 N	104.3	1908, Je., Jy.		−0.00009	−1.0	S. S.	Wild-Freiberg	EI (Wild-Ed.)
33	Katherinenburg	57.0 N	60.6	1908, June		−0.00002	+0.5	S. S.	Wild-Freiberg	EI (Wild-Ed.)
14A	Kew	51.5 N	359.7	1908, Oct.	+0.7	−0.00046	−0.9	W. D.	Jones	Barrow D. C. 33, 1, 2
20A	Potsdam	52.4 N	13.1	1908, Nov.	+0.2	−0.00035	+0.7	W. D.	Wanschaff	EI (Schulze 1.)
35	Rude Skov	55.8 N	12.5	1908, Sept.	+0.2	+0.00053	−0.5	W. D.	Bamberg 1973	EI (Wild-Ed.)
25A	Tiflis (Karsani)	41.8 N	44.7	1907, Dec.		0.00000	+0.4	S. S.	Wild-Edelmann	EI (Wild-Ed.)
36	Upsala	59.9 N	17.6	1908, Sept.		−0.00055	−0.2	W. D.	Lamont	Dover D. C. 60; 3, 4

[1]Bericht über die Versammlungen des Internationalen Meteorologischen Komitees und dessen Kommission für Erdmagnetismus und Luftelektrizität. *Veröff. Met. Inst.*, No. 227, Berlin, 1910, Anhang IV, p. 88.

[2]The figures after the number of dip circle designate the needles used.

TABLE 31 B —*Preliminary Results of Comparisons between the Potsdam Magnetic Standards and Certain Observatory Standards*

[This series of comparisons was made by Dr W Kuhl, of the Potsdam Magnetic Observatory, in 1910, and referred by him to the Potsdam magnetic standards (Wanschaff magnetometer and Schulze earth inductor No 1). His preliminary results as published[1] are given in the table below, ΔD has the sign attached assuming east declination to be positive and the ΔH quantities have been expressed in parts of H.]

No.	Observatory	Approximate Lat.	Approximate Long E.	Date	Potsdam—Observatory ΔD	Potsdam—Observatory $\frac{\Delta H}{H}$	Potsdam—Observatory ΔI	Potsdam Observer	Observatory Instruments Magnetometer	Observatory Instruments Inclinometer
		°	°	1910	′		′			
31	De Bilt	52 1 N	5 2	June	+0 3	−0 00021	−1 2	W K.	Edelmann[2]	Dover D. C [3]
34	Pavlovsk[4]	59 7 N	30 5	July	+0 2	−0 00025	−0 4	W K	Wild-Fr 1	Earth inductor.
37	Val Joyeux.	48 8 N	2 0	June	+0 5	−0 00135	−0 2	W K.	Moureaux[5]	Schulze EI. 61 [6]

[1]Kuhl, W. Vergleichung der Hauptbarometer und der magnetische absoluten Instrumente in de Bilt, Paris—Val Joyeux und Pawlowsk mit denen in Berlin—Potsdam. Berlin, *Veroff Met Inst.*, No 229, 1911, pp. 150-159

[2]The declinations are observed with a special declinometer

[3]The correction for the new earth inductor at de Bilt, on Potsdam, is given provisionally as −3′.

[4]The declination result depends upon a single observation by Dr. Kuhl

[5]Magnets I and II

[6]The correction for the Val Joyeux dip circle, on Potsdam, was +1′ 8.

By means of the following table (31 C) it becomes possible to refer, approximately, the preliminary results of the comparisons given in Tables 31 A and 31 B to the International Magnetic Standards (I. M. S.; see p. 273). This table has been derived with the aid of the C. I. W. comparisons (Table *A*, p. 278), the Russian comparisons (Table 31 A) of 1907–08, and the German comparisons (Table 31 B) of 1910. The two observatories common to the three series of comparisons are Kew and Potsdam. We, accordingly, have the relations shown in Table 31 C. Applying the relation (7) in this table to the Russian series (Table 31 A), and that given by (2) to the German series (Table 31 B), Table *B*, p. 278, is finally derived.

TABLE 31 C.—*Determining the relationship between the International Magnetic Standards and the Pavlovsk Standards.*

No.	Observatories	ΔD	$\frac{\Delta H}{H}$	ΔI	Remarks
		′		′	
1	I M. S.—Kew	+0 6	−0 00008	−1 1	1908–10; Table *A* (p 278).
2	I. M. S.— Potsdam. . .	+0.2	+0 00008	+0 2	1910; Table *A* (p. 278)
3	I. M. S —(Kew and Potsdam) .	+0 4	0 00000	−0 5	Mean of (1) and (2)
4	Pavlovsk — Kew	+0 7	−0 00046	−0 9	1908, Table 31A (p 269)
5	Pavlovsk — Potsdam[1]	+0 1	−0.00015	+0 6	1908–10; Tables 31A, 31B (p 270)
6	Pavlovsk —(Kew and Potsdam).	+0 4	−0 00031	−0 2	Mean of (4) and (5)
7	I M. S — Pavlovsk .	0 0	+0 00031	−0 3	From (3) and (6)

[1]According to Dubinsky and Kuhl, half-weight being given to the latter's results, as he wishes them regarded as provisional ones

REDUCTION TO INTERNATIONAL MAGNETIC STANDARDS.

Thus far in the tables giving the results of C. I. W. comparisons between various magnetic instruments, all quantities obtained have been referred to the same standards, which have been designated as the "C. I. W. Standards." Before making a final summary of the results, it will be desirable to see what corrections may be applied safely to the C. I. W. standards in order to refer them, as nearly as may be practicable at present, to world or international magnetic standards, to be designated as "I. M. S."

In the absence of any agreement among nations as to such international standards, it was necessary for the Department of Terrestrial Magnetism to adopt at the very begin-

ning of its field work in 1905 some standards to which the magnetic elements, observed in all parts of the Earth, could be referred with sufficient accuracy not to vitiate, from a practical standpoint, its published results. Accordingly, after a careful examination of all information available, a first provisional attempt was made to fix "International Standards," and the large Wild-Edelmann instruments No. 26 (declinometer, magnetometer, and earth inductor) of the United States Coast and Geodetic Survey, which are installed at its magnetic observatory at Cheltenham (Maryland), were taken as standards after the following corrections had been applied: for declination and for inclination, 0′.0; for horizontal intensity, $-0.001H$.[1] The latter correction was that derived during the period 1902–07 from comparisons between the Cheltenham standard and 16 magnetometers of most varied design and make, some belonging to the United States Coast and Geodetic Survey and some to the Carnegie Institution of Washington (Department of Terrestrial Magnetism), the constants for each of these magnetometers having been determined independently.

Next C. I. W. magnetometer No. 3 was singled out from a number of magnetometers and its constants were determined in various ways; *e. g.*, the moment of inertia was determined with different bars, the deflection distances and the distribution coefficients were carefully determined, etc. When the constants were established as well as was then possible, it was found that C. I. W. magnetometer No. 3 gave values of H which required a correction of approximately $+0.00015H$ (3γ for Washington) on the provisional international standard. The D-correction for C. I. W. magnetometer No. 3, from limited comparisons, appeared to be practically zero. Accordingly, the C. I. W. provisional standards for D and H to which all land magnetic observations, 1905–13, given in Vol. I and this one, have been referred, was taken to be C. I. W. magnetometer No. 3, with no correction for declination and a correction of $+0.00015H$ for horizontal intensity.

IMPROVEMENT OF STANDARDS FOR DECLINATION AND HORIZONTAL INTENSITY.

Let us next examine into the possibility of still further improving the provisional D and H standards. In Table 31 D there are summarized the corrections of the C. I. W. provisional standards, as determined in two different ways for the period 1907–14. It should be remarked that magnetometer C. I. W. No. 3, on which the C. I. W. provisional standards were based, has been kept almost constantly at Washington, where, from time to time, field magnetometers have been compared with it. All the many magnetometers used in the comparisons have had their constants independently determined. One might apparently assume that the mean corrections resulting from the data in the table ought not to be far

TABLE 31 D.—*Corrections of the C. I. W. Provisional Standards for Declination and Horizontal Intensity*

No.	Based on	Declination correction		Horizontal intensity correction	
		ΔD	Weight	$\frac{\Delta H}{H}$	Weight
I	Mean of 22 magnetometers of the Department of Terrestrial Magnetism, 1907–1914 (comparisons and determinations of constants)	′ +0.04	1	−0.00009	1
II	Mean of 20 observatory magnetometers, 1907–1914 (excluding observatories for which the comparison-differences exceeded allowable limits)	−0.25	1	−0.00022	1
	Mean corrections of C. I. W. Standard, 1907–1914 (on International Magnetic Standards)	−0.1		−0.00015	

from the truth. It should be stated that in the two sets of data, I and II, account has been taken, as far as possible, of the correction to an observed value of H arising from the effect caused by bending of the deflection bar when the magnet is mounted on it.

[1] L. A. Bauer: Preliminary note on an "International Magnetic Standard," *Terr. Mag.*, v. 12, 1907, pp. 161–164.

Although the mean corrections, as is seen, are too small to make it worth while to correct our published land magnetic results for declination and horizontal intensity, they have been applied in Tables A and B (p. 278), which summarize the results of the observatory comparisons. The application of the corrections slightly improves, on the average, the observatory differences on the international standards, as determined in the above manner. As C. I. W. magnetometer No. 3 (corrected by $+0.00015H$) has been the provisional C. I. W. standard, the application of the mean correction $-0.00015H$, shown in Table 31 D, gives for the resultant correction of C. I. W. No. 3 on I. M. S., $0.00000H$; this apparently perfect accord is wholly accidental for no greater accuracy in the quantities in Table 31 D than about $0.0001H$ can be expected.

IMPROVEMENT OF INCLINATION STANDARD.

We were not quite as fortunate in the selection of the provisional standard for inclination I, as was shown above to have been the case with respect to our provisional standards for declination and horizontal intensity. Our provisional I-standard, as has already been stated, was the large Wild-Edelmann earth inductor (No. 26) at the Cheltenham Magnetic Observatory. Up to about 1908 all indications pointed to an agreement of the Cheltenham standard with the Potsdam standard (earth inductor Schulze No. 1) within about 0′.2. Thus, Schulze earth inductor No. 48 (Wild-Eschenhagen pattern), purchased by the Department of Terrestrial Magnetism in 1907, was found, from limited comparisons (3 sets), by the Potsdam Observatory in February 1907 to have a correction of about −0′.27 on the Potsdam standard; from more elaborate comparisons (10 sets), in March and April 1908 at Cheltenham it was found that Schulze No. 48 required a correction of −0′.54 on the Cheltenham standard; the weighted mean of the Potsdam and Cheltenham comparisons was nearly −0′.5. We accordingly adopted as the provisional C. I. W. standard for I, Schulze No. 48 corrected by −0′.5 (for footscrew A south).

The very large number of comparisons, 1907–14, with dip circles and earth inductors of various design and make, gradually began to show that the C. I. W. provisional standard fixed above was about 0′.5 too low on an international standard. This is borne out by the following table (No. 31 E) from which it appears that we should apply a correction of +0′.5 to the provisionally adopted C. I. W. Inclination Standard to refer it to the International Standard. Or, in other words, if the negative correction of 0′.5 which was originally applied to our Schulze earth inductor No. 48 be dropped, this instrument will give inclinations apparently conforming with an International Standard within about 0′.1. Accordingly, all results of inclination comparisons for the quantity (C. I. W. − Observatory), as given in the tables, pp. 214-267, have been algebraically corrected by +0′.5 in referring them to I. M. S.

TABLE 31 E—*Correction of C. I. W. Inclination Standard*

No.	Based on	ΔI	Weight
		′	
I	Mean of 10 Dover land dip circles compared at Washington, 1907–14	+0 55	2
II	Mean of 5 magnetometer-inclinometers (dip circles), made by Department of Terrestrial Magnetism (needles furnished by Dover), and compared at Washington, 1910–14	+0 36	1
III	Mean of 8 earth inductors of various designs belonging to the Department of Terrestrial Magnetism and compared at Washington, 1907–14	+0 61	2
IV	Mean of 20 observatory standards, consisting of 10 dip circles and 10 earth inductors, 1910–14	+0 50	3
	Weighted mean correction of C. I. W. Standard, 1907–1914 (on International Magnetic Standard).	+0 52	

Considering the various errors to which field observations for inclination are subject, it will probably not be found worth while to apply to the inclination results of 1905–1913 given in Vol. I and this volume, a correction which, on the average, will possibly not be

over $+0'.2$ or $+0'.3$. The correction for the field results will not be the full amount, $+0'.5$, for the reason that the dip-circle corrections have been based frequently, not simply upon the C. I. W. standard, but also on observatory standards in various parts of the Earth, in order to eliminate, as far as practicable, the error arising from possible variations of the dip-needle correction with change in magnetic latitude. It was, however, found worth while to correct the results of the observatory comparisons, as they are, on the average, considerably improved thereby.

To recapitulate:

In order to refer the results of the observatory comparisons, as given in the various tables on pp. 214--267, to international magnetic standards (I. M. S.) as accurately as they can be fixed from the data at hand up to 1915, the following corrections have been applied algebraically to the C. I. W. values: for declination, $-0'.1$*; for horizontal intensity,* $-0.00015H$*; and for inclination,* $+0'.5$.

REGARDING THE CONSTANCY OF MAGNETIC STANDARDS.

A word with regard to the constancy of magnetic standards. This depends primarily upon the care and attention that can be paid to the instruments selected, and this in turn depends not only upon the observer-in-charge, but, in no small measure, upon the construction and style of the instruments and the climatic conditions at the place of observation. Thus, for example, if the magnetometer is one in which the magnets are not incased in some protecting sheath, so that it is possible for the fingers or the moist air to come in direct contact with the steel, it is quite possible, by oxidation, to have, in the course of time, sufficient loss of mass to alter appreciably the moment of inertia of the principal magnet. This experience has actually been encountered at magnetic observatories situated in moist tropical regions. For similar reasons in such regions there is a rapid deterioration in the pivots of dip needles, tiny rust spots and pits quickly developing which cause notable errors in the values of the inclination. While it is probable that earth inductors will, in general, be found to be better observatory instruments than are dip circles, they also require scrupulous care, if the highest possible accuracy with them is to be maintained for a period of years.

With respect to the distribution coefficients P and Q, or P', our experience has been that if careful attention is bestowed on the magnets, if they are not allowed to touch each other or other masses of iron or steel, and are not subjected to violent shocks such as are experienced in a fall, then it is inadvisable to make such frequent changes in their adopted values as is the practice at some magnetic observatories. Artificial variations and serious discontinuities in observatory series have, at times, been the result of such changes. Indeed, some observers still think that it is possible to obtain good values of these coefficients from a very limited series of observations.

Even in some of our most strenuous field campaigns extending over periods as long as 2 years and more, during which the instruments were subjected to conditions not experienced at observatories, we have found no cause to make such large changes in the adopted distribution coefficients as are made occasionally at magnetic observatories every 6 or 12 months, in spite of the fact that their instruments have never been subjected to travel. Such frequent changes are likewise very disconcerting if one wishes to test the constancy of comparison-differences, by repeating the observations at intervals of 2 or 3 years.

Judging from our experience during the 10 years, 1905–14, it seems possible, when the above-mentioned precautions are adequately observed, to preserve the constancy of magnetic standards without change of constants, for a period of 5 to 10 years, within an accuracy of $0'.2$, or less, in declination and inclination, and $0.00015H$, or less, in horizontal intensity, *i. e.*, about 3γ or less for the average European observatory.

Let us cite a few cases. As far as can be determined, from numerous intercomparisons, the relations between the D and H standards of the United States Coast and Geodetic Survey and those of the Carnegie Institution of Washington (Department of Terrestrial Magnetism) have remained unchanged, during the period 1905–14, within about 0′.1 or 0′.2 in declination and within about $0.0001H$ (2γ) in horizontal intensity. The same degree of accuracy, however, can not be said to apply to the I-standards of the two respective organizations. As will be seen from Table 7 C, p. 229, the difference (C. I. W. – Cheltenham) has apparently changed by about 1′ between 1910 and 1913; whether this is to be ascribed to some extraneous source of disturbance in the later observations, or whether it indicates some change in the large stationary Wild-Edelmann earth inductor has not yet been definitely settled. From the many comparisons at Washington between the C. I. W. standard and numerous dip circles and earth inductors, no change in the C. I. W. standard greater than 0′.1 or 0′.2 during the period 1907–14 is indicated. Furthermore, up to 1910 there was no indication of any change in the relation of the C. & G. S. and the C. I. W. standards for I amounting to more than 0′.1 or 0′.2; the cause of the apparent difference of 1′ in 1913 is under investigation. (See footnote, p. 226.)

The various checks applied (see pp. 242–243, 252, 253) for strengthening the determination of relations between the C. I. W. standards for D, H, and I, and those of Kew and Potsdam—two observatories where, it is known, every care is bestowed upon instruments and constants—show no indications of changes in the respective standards greater than can be accounted for by purely observational error. Further evidence of the apparent constancy of magnetic standards is obtained from the repeat comparisons at observatories where no change has been made in the observatory instruments and constants. (See, for example, Agincourt, Table 1 C, p. 215; Helwan, Table 12 G, series II and III for H and I, p. 238; Rome, Tables 22 A, 22 B, 22 C, series I and II, pp. 255–256.) It should be remarked that in these repeat comparisons, severer tests have been applied than need be the case for purely inter-observatory comparisons; that is, the intermediary C. I. W. instruments with which the comparisons between the observatory and the C. I. W. standards were effected, have generally been different in the two series of comparisons and, in fact, have been standardized at Washington at different times and have been subjected to severe conditions of field work.

It will be interesting to give, from our accumulated data, some examples showing the apparent constancy of field instruments in spite of exceptionally severe conditions of field travel. On p. 269, Table 30 D, an exhibit has already been made of the constancy of C. I. W. magnetometer No. 5 for the period 1908–10, during which difficult magnetic-survey work in Turkey, Asia Minor, Persia, and Egypt was accomplished, and intercomparison data were secured at 5 magnetic observatories. (See the close agreement in the resulting corrections on the C. I. W. standard as determined by direct comparisons at Washington in December 1907 and February 1908, and by indirect comparisons in the field in January 1910; see also the close agreement in the results of the Kew repeat comparisons, Tables 14 A, 14 B, series I and II, p. 241.)

C. I. W. magnetometer No. 7, used in extensive and strenuous field work in 1908–13 in North America, Central America, Europe, Asia, and Africa, affords another instructive example; in some of this field work it was necessary to travel in a small sailing boat, and often landings had to be made through breakers or surf.

Considering the extent and character of travel in the intervals between the various comparisons at Washington, the small changes in the quantities ΔD and $\Delta H/H$, shown in Table 31 F must be regarded as highly satisfactory.

TABLE 31 F.—*Comparisons of C. I. W. Magnetometer No 7 with Standard at Washington, 1908–13*

No.	Place of comparisons	Date	C I W — Magnetometer 7				Remarks
			ΔD	Weight	$\frac{\Delta H}{H}$	Weight	
			′				
1	Washington .	1908, Mar	0.0	2	−0.00104	2	From June to November 1908 used by J P Ault and C. C Stewart in difficult field work in Northwest Canada, involving 1600 miles travel by canoe
2	Washington	1908, Nov	+0.1	1	−0.00095	1	
3	Washington .	1909, Sept.	+0.4	1	−0.00096	1	From November 1908 to July 1909 used by W. H. Sligh in severe field work in West Indies and Central America.
4	Washington . . .	1913, Jan .	−0.3	2	−0.00107	2	From January 1910 to December 1913 used by W H. Sligh in strenuous field work in Turkish countries, Balkan States, and in Northern and Northwestern Africa.
	Weighted mean 1908–13		0.0		−0.00102		

Another equally interesting exhibit is afforded by C. I. W. magnetometer No. 13, used by Observer D. W. Berky in West Africa in 1912 and on his Trans-Saharan expedition of 1913.

TABLE 31 G.—*Comparisons of C I. W. Magnetometer No. 13 with Standard, 1912–14*

No	Place of comparisons	Date	C. I. W.— Magnetometer 13				Remarks
			ΔD	Weight	$\frac{\Delta H}{H}$	Weight	
			′				
1	Washington	1912, Mar	−0.1[1]	2	+0.00008	2	The comparisons at Washington were made between C I W magnetometers 3 and 13, at Timbuktu, Africa, between C. I. W. magnetometer 20 referred to C. I. W. standard by comparisons at Washington in June 1912, and C I. W magnetometer 13
2	Timbuktu	1913, July	−0.2	1	+0.00003	1	
3	Washington .	1914, Apr–May	−0.1	2	−0.00018	2	
	Weighted mean .		−0.1	. . .	−0.00003	.	

[1]As derived from previous comparisons.

EXPLANATIONS OF TABLES *A*, *B*, AND *C*.

Table *A* (p. 278) gives the corrected results derived (see p. 273) for all magnetic observatories (21), at which direct comparisons have been obtained by the observers of the Department of Terrestrial Magnetism, in the course of their field work. Three observatories have been omitted from the list for the reason that their instruments at the time were not such as to meet the demands of accurate magnetic work. The Samoa Observatory at Apia has been omitted for the reason that the instruments have been changed from time to time and also because they are all referred ultimately to the Potsdam standards; there is also some uncertainty in the data supplied us. For some of the observatories those results regarding which, for one reason or another, there may be some doubt, are found omitted in the table. Furthermore, 4 observatories had to be omitted entirely, pending receipt of desired data.

Although the quantities $\Delta H/H$ have been retained to the fifth decimal, no claim, of course, is made as to the correctness of the last figure; indeed, some of them may be in error 10 units or more in this decimal, but it is hoped that, in general, the error may not exceed a unit in the fourth decimal. While the ΔD and ΔI quantities are given to the nearest 0′.1, no claim to this accuracy is made. Nevertheless, whenever the conditions for accurate comparisons were good, it is not believed that the error in these quantities will be

more than a few tenths of a minute; in some instances where the conditions were not good, when, for example, it was not possible to exchange stations because it was not feasible to observe with the comparing instrument at precisely the same station where the compared instrument was mounted, the error in ΔD or ΔI may be as much as 0′.5 or more—depending upon the precise circumstances. There is no question, however, that the declination or inclination standards at some observatories may be in error by as much as 1′. It is unfortunate that rather too frequently those who are intercomparing observatory standards fail to get declination results. Our experience has shown that it can not be assumed that the instrumental declination-differences are negligible quantities, if one strives to secure the attainable accuracy in magnetic work. It is also of interest to know that to obtain the same degree of accuracy in the determination of the vertical intensity, Z, as appears possible with the very best magnetometers for H—about 0.00015 to 0.00010 part—it is necessary to determine the inclination, I, at observatories in medium magnetic latitude, to about 0′.2.

But few can realize the very large amount of work and patience involved in securing the comparison data set forth in Table *A*. In no instance have the comparisons been obtained as the result of special expeditions, but invariably in the course of an observer's field work, and with the instruments used by him in the field. A critical examination of the results will show that they compare favorably with those obtained by others, whose special mission it was to intercompare observatory standards. There is thus afforded evidence not only that the observers of the Department of Terrestrial Magnetism performed their work faithfully and zealously, but also that the observatory authorities did their utmost to perform their part. It is a great pleasure to acknowledge here our obligations to the directors and observers at the various observatories for the courtesies shown and the assistance rendered.

Table *B* (p. 278) contains the preliminary results of indirect comparisons between the International Magnetic Standards and 8 magnetic observatories not contained in Table *A*, derived as explained on p. 270 (Table 31 C.)

Table *C* (p. 278) is an extract from Table *A*.

An approximate attempt was made to indicate in the columns, "Grade of Value," of Tables *A* and *B*, by the letters *a*, *b*, *c*, and *d*, the degree of reliability of the quantities ΔD (declination difference), $\Delta H/H$ (horizontal-intensity difference), and ΔI (inclination difference); *a* stands for the highest grade of reliability, and *d* for the lowest. In determining the grade, as full consideration as possible was paid to the conditions under which the results were obtained; whether there were any independent checks; whether station-differences were eliminated, etc., etc. The grade *c* was assigned to all the results in Table *B*, as they depend upon the preliminary reports of Messrs. Dubinsky and Kühl and are, accordingly, subject to future correction.

In the three columns, under the general heading of "I. M. S. – Observatory," are given the resulting algebraic differences for the three magnetic elements, declination (D), horizontal intensity (H), and inclination (I), between the adopted international magnetic standards (I. M. S.) and the observatories named in the second column, the standards of which are designated in the last two columns. *It must be remembered that the quantities apply only for the instruments and constants as used at the time of the comparisons.*

WHAT ARE THE INTERNATIONAL MAGNETIC STANDARDS?

It has been explained in this report how, by more extensive and more varied intercomparisons of magnetic instruments of all kinds than have ever been carried out before, we have arrived at what have been termed "International Magnetic Standards." It has been shown that during the period of our preliminary investigations these standards may be regarded as having remained constant within all practical requirements. The provisional international standards for declination and horizontal intensity, chosen in 1907, were found to agree with the international standards of 1914 within 0′.2 in declination and

$0.0001H$ in horizontal intensity. We have been able to refer the standards of nearly all of the chief magnetic observatories to these international standards (see Tables A and B).

The arduous work being over, we can now give, on the basis of the three observatories which show the smallest horizontal-intensity corrections, and for which the grade of reliability a could be assigned throughout, a definition which will answer all requirements. The International Magnetic Standards, if desired, may be taken to be the absolute magnetic instruments at either one of the three observatories, Kew, Potsdam, or Washington (Department of Terrestrial Magnetism of the Carnegie Institution of Washington), provided the *approximate* corrections given in Table C be applied algebraically, remembering that the signs of the corrections are positive for east declination and inclination of north end of needle below horizon.

Naturally the more of these observatories any one employs in determining the relations between his magnetic standards and the International Magnetic Standards, as above arbitrarily defined, the more correct will be his results. Whether the corrections at Kew and Potsdam for 1910, given in Table C, also hold for 1914 depends upon whether any change has been made at these observatories in the instruments or in their constants during the interim. As already stated elsewhere, the corrections, on absolute standards, for the declination and inclination may be in error by $0'.1$ or $0'.2$ and for the horizontal intensity by about $0.0001H$. Accordingly, *no undue significance is to be attached to the circumstance that the corrections for the Washington standards are apparently the smallest of the 3 observatories, nor to the fact that the apparent zero correction of the Washington standard for horizontal intensity happens to be the mean of the corrections for Kew and Potsdam.*

From other studies we have made we are confident that the mean result from a combination of the observatories in Table C will come as close to an absolute magnetic standard as is possible by any magnetic or electric method for determining the magnetic elements.

CONCLUDING REMARKS.

In conclusion, we desire to say that we ourselves regard the past work rather in the nature of a preliminary investigation, leaving to the future and to others a more complete examination into the various questions involved. It should be distinctly understood that there is no recommendation in this report that observatories adopt our international magnetic standards, or the corrections of their instruments on these standards, as shown in Tables A and B. If, however, any observatory is induced by our results to purchase its instruments with especial attention to their design and construction, to make an independent investigation of their accuracy, and to arrange for the *scientific* control of the instrumental constants, our purpose has been accomplished. While any desire to establish universal magnetic standards is disclaimed, it has been found in a number of instances that, when the observatory staffs have been led to investigate the causes of the rather large differences which were disclosed in the comparisons at their observatories, they have found sources of error, the remedying of which has effected improvement.

TABLE *A.—Summary of Results of Direct Comparisons of Magnetic Observatory Standards.*

[East declination and inclination of north end of needle below horizon are regarded as positive]

No.	Observatory	Approximate			Date	I. M. S —Observatory			Grade of Value			Observatory Instruments	
		D	H	I		ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
		°	cgs.	°		′		′					
1	Agincourt. .	− 6	163	+75	1906–12		+0 00008	+0 8		*a*	*b*	Elliott 98[1]	EI 89
3	Alibag. .	+ 1	.368	+24	1911	+0 3	−0 00108	−0 1	*b*	*b*	*b*	Cooke 7	DC 160
4	Antipolo.	+ 1	.382	+16	1912, Feb	+1 8	−0 00214	+0 6	*c*	*c*	*d*	Elliott 28	DC 7, 2.
6	Batavia .	+ 1	367	−31	1911, Nov	+0 5	+0.00122	+0 2	*b*	*b*	*b*	Mey , Jones 1[2]	EI 47.
7	Cheltenham. . . .	− 6	198	+71	1908–13	+0 1	−0 00101	+0 7	*a*	*a*	*a*	Wild 26	Wild EI 26 [3]
8	Christchurch .	+17	226	−68	1906–08	+1 1	+0 00064	−0 9	*b*	*b*	*b*	Kew 1 . . .	DC. 147, 1, 2, 3.
9	Dehra Dun .	+ 3	332	+44	1909, Oct	0 0	+0 00144	+0 4	*b*	*b*	*b*	Elliott 17 .	EI. 30.
10	Falmouth . .	−18	188	+67	1909, Oct	0 0	−0 00049	−0 8	*b*	*b*	*b*	Elliott 66	DC. 86; 1, 2.
12	Helwan. .	− 2	300	+41	1908–14	+0 3	−0 00056	+1 1	*c*	*b*	*b*	Elliott 87	DC. 193.
13	Hongkong . .	0	372	+31	1907–11	+1 1	+0 00119	+0 2	*c*	*d*	*c*	Elliott 55	DC. 71, 3, 4, 7, 8
14	Kew . .	−16	185	+67	1908–10	+0 6	−0 00008	−1 1	*a*	*a*	*a*	Jones .	DC. 33, 1, 2.
15	Mauritius .	− 9	233	−53	1911, Aug.	+0 4	−0 00065	+0 3[4]	*b*	*b*	*b*	Elliott 24	EI. 4
17	Pilar .	+ 9	256	−26	1911–13	−0 3	−0 00028	+0 3	*b*	*b*	*b*	Kew 175	DC 216; EI 3
18	Pola . .	− 9	222	+60	1910, Feb.	−0 4	+0 00039	+0 6	*b*	*b*	*b*	Bamberg 7904.	Wild EI
19	Porto Rico. . .	− 2	288	+50	1910, Jul .	+0 5	−0 00097	+1 0	*b*	*c*	*b*	Cooke 31[5] . .	EI 1.[5]
20	Potsdam . .	− 9	188	+66	1910, Feb.	+0 2	+0 00008	+0 2	*a*	*a*	*a*	Wanschaff	EI. (Schulze 1)
21	Rio de Janeiro[6]	−10	.246	−14	1913, May	+0 5	−0 00029		*b*	*b*		Cooke 20.	
22	Rome . .	− 8	238	+57	1911–13	+0.1	+0 00028	−0 4	*a*	*a*	*a*	Dover 122	DC. 51, 1, 2
27	Washington . .	− 5	192	+71	1907–14	−0 1	0 00000	0 0	*a*	*a*	*a*	C. I. W 3	EI. 48
28	Zikawei . . .	− 3	331	+46	1907	−1 1	+0 00042	−0 4	*b*	*b*	*b*	Elliott 49	DC 33; 14
29	Lukiapang[7] .	− 3	333	+46	1911, Sep	−1 5	+0 00084	0 0	*b*	*c*	*b*	Elliott 49.	EI. 42

[1]Elliott 98 corrected for H (see p. 216, equation VI), for D, Toronto declinometer is used

[2]Reconstructed Meyerstein unifilar for D; Jones magnetometer No. 1 for H.

[3]See footnote, p 226.

[4]This is the correction as determined at Washington in 1913 (Table 27 E, p. 264) before the earth inductor was sent to Mauritius

[5]Referred by the United States Coast and Geodetic Survey to the Cheltenham standards (No. 7).

[6]New magnetic observatory located at Vassouras, 77 km. northwest of Rio de Janeiro.

[7]Succeeded Zikawei in March 1908.

TABLE *B.—Summary of Preliminary Results of Indirect Comparisons of Magnetic Observatory Standards.*

[East declination and inclination of north end of needle below horizon are regarded as positive]

No.	Observatory	Approximate			Date	I. M. S.—Observatory			Grade of Value			Observatory Instruments	
		D	H	I		ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
		°	cgs.	°		′		′					
31	De Bilt .	−13	185	+67	1910, Jun	+0 5	−0 00013	−1 0	*c*	*c*	*c*	Edelmann	DC.
32	Irkutsk . .	+ 2	199	+70	1908, Jul		+0 00022	−1 3		*c*	*c*	Wild-Freiberg	EI. (W-E).
33	Katherinenburg	+11	176	+71	1908, Jun		+0 00029	+0 2		*c*	*c*	Wild-Freiberg.	EI. (W-E)
34	Pavlovsk	+ 1	.166	+71	1908–10	0 0	+0 00031	−0 3	*c*	*c*	*c*	Wild-Freib'g 1[1]	EI.
35	Rude Skov .	−10	174	+69	1908, Sep	+0 2	+0 00084	−0 8	*c*	*c*	*c*	Bamberg 1973	EI. (W-E)
25A	Tiflis (Karsani)	+ 3	254	+56	1907, Dec		+0 00031	+0 1		*c*	*c*	Wild-Edelm'n.	EI. (W-E).
36	Upsala .	−11	164	+71	1908, Sep		−0 00024	−0 5	.	*c*	*c*	Lamont	DC 60, 3, 4
37	Val Joyeux . .	−14	.197	+65	1910, Jun	+0 7	−0 00127	0 0	*c*	*c*	*c*	Moureaux	EI 61.

[1]The declination standard at Pavlovsk is a special declinometer.

TABLE *C.—Corrections on I M. S. of the Magnetic Standards at Kew, Potsdam, and Washington*

[East declination and inclination of north end of needle below horizon are regarded as positive]

Observatory	Magnetometer	Inclinometer	Corrections on I. M. S. for			
			Declination	Horizontal Intensity	Inclination	Year
			′		′	
Kew	Jones unifilar .	Barrow dip circle No 33, needles 1, 2	+0 6	−0 00008H	−1 1	1910
Potsdam	Wanschaff	Schulze earth inductor No. 1. .	+0.2	+0.00008H	+0 2	1910
Washington.	C. I. W. No. 3 . .	Schulze earth inductor No. 48.	−0 1	0 00000H	0 0	1914